FACTORS AFFECTING PROXIMATE COMPOSITION OF PREY SPECIES IMPORTANT TO MARINE VERTEBRATE PREDATORS IN THE NORTHWESTERN ATLANTIC

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Factors Affecting Proximate Composition of Prey Species Important to Marine Vertebrate Predators in the Northwestern Atlantic

by

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Abstract

Energy-density values of prey species are essential inputs for bioenergetic models of consumption. Diets of marine vertebrate predators in the northwestern Atlantic are reasonably well described, but the proximate composition (PC) and energy density (ED) of these prey species, and the factors affecting them, are poorly known, particularly for those prey sizes commonly eaten. The purpose of this study was to estimate PC and ED of important prey species, and investigate important sources of variation.

Twelve species were collected in waters near Newfoundland and Labrador: Atlantic cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*), sand lance (*Ammodytes dubius*), Arctic cod (*Boreogadus saida*), northern shrimp (*Pandalus borealis*), redfish (*Sebastes* spp.), Greenland halibut (*Reinhardtius hippoglossoides*), squid (*Illex illecebrosus* and *Gonatus fabricii*), capelin (*Mallotus villosus*), Atlantic herring (*Clupea harengus*) and daubed shanny (*Lumpenus maculatus*). ED was estimated from replicates of all samples by determining moisture, lipid, protein and inorganic content. ED differed among species and was influenced by body size, season, geography, and year of collecting. Herring, capelin and *Gonatus* squid had the highest ED; Atlantic cod, American plaice, sand lance, Arctic cod and northern shrimp had the lowest. ED increased greatly with size (age) in capelin, and also in Greenland halibut and *Illex* squid. Other species showed no strong relationships of ED to body size. ED was greater in male than female northern shrimp. ED in capelin was highest in winter. Arctic cod had higher ED offshore than nearshore in eastern Newfoundland. Interannual variation in ED was found in Greenland halibut and Atlantic herring. Levels and variation in ED are discussed in relation to predator physiology, ecology, and life history.

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Chapter One: Introduction

Estimating total prey consumption by marine predators is an essential step towards modeling trophic interactions with prey stocks, as well as providing one source of information necessary in estimating the impacts of this predation. Bioenergetic models of prey consumption (e.g., Majkowski and Waiwood 1981; Markussen et al. 1992; Olesiuk 1993; Mohn and Bowen 1996; Stenson et al. 1997) require information about energy density (ED) of prey,[1] which is commonly derived from analyses of proximate composition (PC). PC has been determined for many marine fish and invertebrate species of commercial importance (Stansby and Hall 1965; Stoddard 1968; Anonymous 1969; Sidwell et al. 1974; Holdway and Beamish 1984; Steimle and Terranova 1985; Krzynowek and Murphy 1987). Nevertheless, most determinations of PC are ecologically uninformative, because they have not been made for the size or species of prey eaten by marine predators (such as sand lance and Arctic cod; Hislop et al. 1991; Lawson and Stenson 1995; Lawson et al. 1995). Furthermore, most published PC estimates refer to composition of selected body components, such as muscle or gonads, rather than entire prey items (e.g., Sidwell et al. 1974). Commercial samples are also rarely representative of the important areas or seasons of feeding by predators (Bowen et al. 1993), and do not consider important annual events in the prey's life cycle that may influence PC, such

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[1] Most bioenergetic models of consumption by marine predators are multiplicative. A predator's consumption of a prey species is estimated by dividing the predator population's total energy requirement (which is the product of predator population, individual predator's biomass and mass-specific estimates of energy requirement) by the proportion of the predator's diet accounted for by the prey item, and the energy density of that prey item (e.g., Nordøy et al. 1995).

as spawning (Woyewoda et al. 1986). Finally, most analyses concern commercially important species, rather than those species that are ecologically important in trophic interactions.

The weaknesses just noted apply to estimates of food consumption by marine mammals in the northern Atlantic (Markussen and Øritsland 1991; Markussen et al. 1992; Stenson et al. 1995; Mohn and Bowen 1996). These estimates have not considered seasonal variation in prey ED because data for key species are lacking (e.g., Mårtensson et al. 1996).

The purpose of this study was to provide PC and ED estimates for a variety of species that are common constituents of the diets of marine predators such as cetaceans, pinnipeds and seabirds, so that understanding of trophic-energetic relationships between marine predators and their prey could be improved.

In addition to its importance for bioenergetic modelling, information on ED also permits investigations into many important related topics. For example, differences in ED among prey species should be reflected in dietary preferences of predators: all else being equal, predators should select prey that yield the greatest amount of energy per unit mass (Krebs and Davies 1978; Lawson et al. 1998). Such preferences, coupled with predator mobility, longevity, and (particularly for seabirds, cetaceans and pinnipeds) learning ability, likely influence where and when predators feed.

I assessed and quantified factors (season, location, size, sex) that may affect PC and ED of prey of marine predators in the northwestern Atlantic. Levels of and variation in PC and ED were interpreted in light of current knowledge of the digestive efficiency and food preferences of northwestern Atlantic vertebrate predators. Finally, I summarize current information on life history, abundance and distribution of the prey species analysed in this study.

Chapter Two: Materials and Methods

1) Specimen Collection and Storage

Specimens of 12 important prey were collected opportunistically during groundfish surveys by the Department of Fisheries and Oceans (DFO), and by DFO's Sentinel fisheries program, in areas near Newfoundland and Labrador (Table 1; Figure 1). Daubed shanny were collected at the Gannet Islands, Labrador (53° 57 N 56° 31 W). Where possible, samples were collected from more than one location, season and year. Most samples (84%) were collected in 1995 and 1996, and about half were collected from locations more than 30 km from shore (designated as *offshore*; other samples are considered as *nearshore*). Other samples were collected during the years 1991 to 1994.

Specimens were frozen fresh at sea (in -10°C sample freezers), stored in sealed plastic bags, and on return to shore, were stored at -20°C until processing. The *Illex* squid and Atlantic herring were commercial samples that were flash-frozen at sea and stored at -20°C in plastic-lined cardboard boxes.

2) Specimen Preparation and Measurement

Prey samples were sorted by location, season, sex (where possible), and size (body length and mass). Frozen specimens were thawed at room temperature for a maximum of 2 hr to reduce evaporative water loss, after which they were measured for mass (to the nearest 0.1 g) and straight-line lengths (to the nearest 0.1 cm). I measured standard length (tip of snout to caudal peduncle) for American plaice, fork length for other fish species (tip of snout to fork of tail), carapace length for shrimp (dorsal carapace length, from anterior tip of rostrum to posterior margin of carapace, on the dorsal midline) and mantle length for squid (posterior tip of mantle

to anterior margin of mantle). Sex was determined by examination of the gonads of each of my specimens; I was assisted by trained DFO laboratory staff with extensive experience in performing this task as part of regular scientific trips for DFO. In some cases specimens were too small to determine sex, and these were not used in analyses of sexual differences. Some specimens of Greenland halibut, *Gonatus* squid and daubed shanny contained large meal boli in their stomachs. As this would influence PC and ED analysis results (creating in an additional, unquantified source of variation), stomachs were emptied before these specimens were dried and ground.

Specimens were cut into small pieces and dried to constant mass in a convection oven (Precision Scientific Inc., 3737 West Cortland Street, Chicago, IL) at 105°C overnight for small samples, or until a constant mass was reached for large samples (AOAC 1990). Carapaces were removed from half of the northern shrimp specimens, but ED of shelled ($\tilde{x}$ = 4.9 kJ•g^{-1} wet mass, SD = 0.64) and whole ($\tilde{x}$ = 4.7 kJ•g^{-1}, SD = 0.33) shrimp were not significantly different (one-way ANOVA $F_{[1,31]} = 0.49$, $p = 0.489$), so these data were combined for analyses. Otoliths and squid beaks were removed prior to analysis as part of other studies. Dried samples from large specimens were ground in an electric grinder (Retsch, RMO model, GmbH & Co. KG, 657 Hanni, Germany) to a uniform consistency. Small specimens, or those with high lipid content, were ground manually in a ceramic mortar. Homogenized samples were stored in sealed 25 ml plastic vials. The grinder, mortar and pestle were cleaned with acetone and dried thoroughly between samples.

3) Analyses of Proximate Composition

Proximate composition (water, lipid, protein and inorganic content) of the species used in this study was determined using the methodology of the Canadian Food Inspection Agency, St. John's, Newfoundland, which are based on recommendations of the AOAC (1990).

a) Water content

Homogenized specimens were weighed (± 0.0001 g; Mettler AE160) on a covered digital scale, placed in 13 cm aluminum pans, and dried to constant mass overnight at 105°C in a convection oven (Precision Scientific Inc., 3737 West Cortland Street, Chicago, IL). Per cent moisture content was calculated using the difference between homogenized and dried sample masses. I reduced water loss from the specimens by limiting thawing time prior to homogenization, and being careful to process samples over the drying pan such that free water was collected in the pan and included in the pre-drying mass measurement.

b) Lipid content

Lipid content was determined for two replicates of 1 to 3 g, dried subsamples of each species by diethyl ether extraction in a water-cooled fat extractor (Labconco Corporation, Kansas City, Missouri USA 64132). Lipid extraction's were run for at least 16 hr, after which the collection flask was dried at 100°C for 30 min, then placed in a sealed desiccator for at least 1 hr, to remove any remaining diethyl ether residue and water. The mass of the lipid remaining in the flask was divided by the original sample mass to derive the per cent lipid content of the replicate samples.

c) Protein content

Per cent protein content was determined as % protein = 100 - (% moisture + % lipid + % inorganic). In these calculations I assumed that carbohydrates were a negligible component as has been done in similar studies (e.g., Sidwell et al. 1974; Percy and Fife 1981).

To verify calculated protein values, I assayed the protein content directly for random, replicate subsamples of all species using the Kjeldahl method (Gorsuch, 1976; Chen et al. 1988).

The protein assay was subdivided into three stages: digestion, distillation and titration. The maximal number of samples prepared using the titrator was 20 (40 tests, with two replicates per sample). A Mettler electronic balance was used to record sample mass; 0.250 to 0.300 g of each sample was analysed. Samples were transferred to digestion tubes located in the test tube rack. While samples were weighed and the data entered into the titrator program, the digestion unit was pre-heated to 420°C.

At the beginning of the digestion phase, Kjeltabs (Thompson and Capper Ltd., 11 Hardwick Road, Astmoor Industrial Estate, Runcorn, Cheshire, England) were added to each test tube, then 15 ml of sulfuric acid were added and mixed with the sample in the test tube. The test tube rack was then placed on the digestion unit for 55 min (Digestion System 20, Tecator AB, Box 70, S-263 01 Höganäs, Sweden) with an exhaust system (ES) placed above. After this period, the test tube rack was removed with the ES and cooled for 25 min. The ES was then removed from the top of the test tube rack and digested samples were diluted in 85 ml of distilled water. The contents of each test tube were then mixed thoroughly.

To initiate the distillation phase, 25 ml of boric acid were added to each of 20 sample cups. Each cup was placed in the upper position on the platform of the distilling unit (Kjeltec System 1028 Distilling Unit, Tecator AB, Box 70, S-263 01 Höganäs, Sweden). The distillation was completed after 3 min, then the contents of each digestion tube were distilled into a second sample cup.

The sample changer (Mettler ST 20/Sample Changer, Mettler Instrumente, CH 8606 Greinfensee, Zurich, Switzerland) was calibrated using standard buffer solutions (pH 4.0 and pH 7.0). The second sample cups were placed on the changer turn table, and the titrator (Mettler DL 20/Compact Titrator, Mettler Instrumente, CH 8606 Greinfensee, Zurich, Switzerland) started. The percentage of protein in the samples was calculated automatically by the titrator. Calculated and Kjeldahl-derived protein values were not significantly different (paired *t* test, $t = 1.47$, $p = 0.149$, $df = 44$), so combined values are cited throughout.

d) Inorganic content

Per cent inorganic content was estimated by combusting 0.500 g samples in a muffle furnace (model FA1850; Thermolyne Corporation, Dubuque, IA) at 550°C for 16 hr. After 24 hr the cooled samples were re-weighed to determine the ash content.

e) Energy density

I analysed two replicates for every lipid and protein assay. The average of these replicates were used as the value for each specimen. ED was calculated assuming 20.0 $kJ \bullet g^{-1}$ for protein and 38.0 $kJ \bullet g^{-1}$ for lipid (Ricklefs and Schew 1994). In a comparative study, when ED was calculated from proximate analysis using ("indirect") conversion factors of 39.54 $kJ \bullet g^{-1}$ for lipid and 23.64 $kJ \bullet g^{-1}$ for protein, results were 4.4 percent higher than those obtained from bomb calorimetry (Craig et

al. 1978). This discrepancy was eliminated when Craig et al. used a lower, directly-determined energy density for the extracted lipid fraction (35.52 $kJ \bullet g^{-1}$). Since I used conversion factors less than the greater, "indirect" values of Craig et al. (see Materials and Methods) results of this study are likely to be more similar to those that might have been obtained using bomb calorimetry.

There are a variety of other energy equivalent values for lipid (and protein) in the literature: 39.5 $kJ \bullet g^{-1}$ (Paine 1971), 39.356 $kJ \bullet g^{-1}$ (Pike and Brown 1975), 39.33 $kJ \bullet g^{-1}$ (Schmidt-Nielsen 1990) and 39.8,35.5 or 33.0 $kJ \bullet g^{-1}$ (Lucas 1993). Given this variety of energy equivalents, it would be desirable that published ED results be accompanied by both the PC and energy density equivalents (if ED values are not obtained with direct methods such as bomb calorimetry) to facilitate interpretation and conversion by readers who might employ other energy equivalents.

ED values are expressed per unit wet mass, unless stated otherwise. In addition to my samples, I included unpublished data on other capelin and redfish from B. Nakashima and K. Kennedy (Department of Fisheries and Oceans, St. John's, Newfoundland). The latter samples were analysed using identical methods to those of this study, although each capelin data point represents the mean value for a homogenate of 10 fish.

f) Statistical analyses

One-way ANOVA, simple linear regression and descriptive statistics were computed using the Statview programme (Abacus Concepts, 1918 Bonita Avenue, Berkeley, California 94704-1014) on a Macintosh microcomputer. Data were examined for normality, homogeneity of variance, and independence.

Coefficients of variation for moisture (2.9%), lipid (0.2% of dry replicate), protein (0.3% of dry replicate) and ash (0.4%) obtained using these analytical techniques are low (Anonymous 1966; 1976; Hanson 1973). Per cent lipid, protein and inorganic estimates were converted to percentages of the original wet sample mass and arcsine-transformed [$q = \text{arcsine}\ (p^{0.5})$, where p is a proportion] for all statistical analyses (Glass et al. 1972; Hays 1988). This transformation normalized residuals successfully.

Analyses were restricted to univariate statistics, since sampling was opportunistic and appropriate sample designs for other statistics (e.g., multiway ANOVA) were not possible (e.g., Keppel 1982; Keppel and Zedeck 1989). *Post-hoc* tests were used for assessing effects of season, gender and body size, as data permitted (Wilcox 1987; Keppel and Zedeck 1989; Neter et al. 1990).

Chapter Three: Results

1) Interspecific Differences in Prey Composition

There were significant differences in ED, per cent protein, and per cent ash among species (per cent lipid and moisture were not tested, because they are so highly correlated with one another and with ED; Tables 2 to 5; Figure 2). ED ranged between 4.2 and 8.7 $kJ \bullet g^{-1}$, being highest in Atlantic herring and capelin - more than double the estimate for Atlantic cod. *Gonatus* squid also had high ED levels. Protein content varied significantly among species, with an overall range of 12 to 20 percent. It was highest in daubed shanny and lowest in Greenland halibut. The range of ash content was 1.3 to 4.6%; it was highest in northern shrimp and lowest in Atlantic herring. PC data for all specimens assayed in this study are presented in Appendix B.

2) Size and Sex-related Differences in Prey Quality

The relationship of ED to body mass was investigated in prey species with adequate sample sizes. ED was positively correlated with body size in samples of seven species, with steepest slopes for capelin (0.44, 0.48), *Gonatus* squid (0.29), and Greenland halibut (0.13; Table 6 and Figure 3). Other significantly positive slopes ranged from 0.03 to 0.08. ED declined strongly with body length in Atlantic herring (slope = -0.39); other significantly negative slopes were -0.08 (an Arctic cod sample) and -0.02 [an Atlantic cod sample; Figure 3; in this figure I have also shown the size range of Greenland halibut and Atlantic cod most commonly recovered from the stomachs of harp seals in the Northwest Atlantic (Lawson et al. 1995; Lawson and Stenson 1997)].Overall, regression analyses revealed significant variation in the relationship of ED to body length both within and across species.

Sexual differences were tested for within samples from both the same locality and season. In these analyses, only northern shrimp (*Pandalus*) exhibited a significant sexual difference in ED (Table 7).

3) Seasonal Differences in Energy Density in Capelin

Significant effects of season on ED was found for capelin, which was the only species tested(Table 8). Capelin had much higher ED in winter than summer from eastern Newfoundland, offshore. ED of the summer sample of sand lance was insignificantly higher than the winter sample (these samples were from different areas, however, which confounds interpretation).

4) Geographic Differences in Prey Quality

ED varied geographically in several species (Table 8). In Arctic cod, ED was significantly higher in an offshore than a nearshore sample from eastern Newfoundland in winter. A similar trend was found for another comparison of offshore and inshore samples, but these were from different geographic regions. Samples of Atlantic cod from eastern Newfoundland and Labrador did not differ significantly from one another (both were sampled from nearshore, in summer).

5) Interannual Differences in Prey Quality

There were significant interannual differences in ED of two species that were collected in the same season in different years (Table 8). ED in the 1992 sample of Greenland halibut was about 25% higher than the estimate for fall 1995. ED of Atlantic herring samples from the 1992 and 1993 also differed significantly, by about 10%.

Chapter Four: Discussion

This study revealed large interspecific, seasonal, geographic and size differences in energy density of fish prey, which must be important for prey choice, feeding intensity, and movements of vertebrate predators. My results also point to discrepancies between PC and ED values obtained using analyses of particular body components (rather than the entire animal as in this study; see Table 9 for other published values).

Capelin are a key species for vertebrate predators in the northwestern Atlantic. In this study, capelin caught in the fall had the highest lipid and ED of any of the species I analysed, or that have been reported for the northwestern Atlantic (Anonymous 1969; Steimle and Terranova 1985; Brekke and Gabrielsen 1994; Mårtensson et al. 1996; Table 9). Capelin feeding behaviour varies seasonally, with greater feeding intensity before and after the spawning season (Appendix A). The proportion of lipid (and ED) of fish is influenced by diet (e.g., Love 1970), and the high ED values in the winter probably reflect the influence of feeding on PC. Capelin had significantly lower ED during the June spawning period, when they do not normally feed (Winters 1970). Jangaard (1974) similarly reported that the fat content of capelin from the Barents Sea declined by as much as 80% during spring spawning, with a return to high levels in the fall.

The Atlantic herring is also a significant pelagic prey item in the northwestern Atlantic. The herring I analysed had high energy content, as in earlier studies (Steimle and Terranova 1985; Mårtensson et al. 1996; Table 9). Seasonal variation in ED has been reported for herring in the Barents Sea, with high levels in the fall (Stoddard 1968).

The abundance, schooling behaviour (Jangaard 1974), high ED, and high digestibility (Mårtensson et al. 1994; Lawson et al. 1997) of both capelin and Atlantic herring may explain why they are predominant items in the diet of Atlantic cod (e.g., Fahrig et al. 1993), seabirds (e.g., Montevecchi and Piatt 1984; Cairns et al. 1990; 1991), cetaceans (e.g., Whitehead and Carscadden 1985; Fontaine et al. 1994), and harp seals in certain parts of the northwestern Atlantic (Fisher and Mackenzie 1955; Sergeant 1973; Murie and Lavigne 1991; Beck et al. 1993; Lawson et al. 1995). The relatively high ED for capelin and herring (Hodder et al. 1973, this study) in the fall coincides with a period when harp seals are feeding heavily and gaining mass prior to breeding. Harp seals must satisfy an increased energy demand during this time, so it is understandable that capelin are a preferred prey offshore, when these seals have prey choices (Lawson et al. 1998).

An important factor that could not be considered in this study is prey availability. Even if predators prefer high-energy prey, locally or seasonally abundant prey of low ED may be more economical to prey on. For example, the diet of harp seals from nearshore northeastern Newfoundland since 1986 has been dominated by Arctic cod (Lawson and Stenson 1995). Lilly et al. (1994) reported an increase in abundance and biomass of Arctic cod bycatch in groundfish bottom trawls off southern Labrador and eastern Newfoundland from the mid 1980s to the early 1990s. If there was a significant increase in Arctic cod biomass relative to capelin in the nearshore areas where harp seals have been collected, the seals' increased reliance on Arctic cod since 1986 may represent a shift in diet in response. However, although harp seals digest Arctic cod less efficiently than capelin (Lawson et al. 1997), a dietary shift in nearshore areas may not necessarily entail a significant reduction in diet quality because capelin and Arctic cod have similar ED there. A

similar dietary change in response to prey availability may have occurred when common murres (*Uria aalge*) breeding in Labrador switched from capelin in the early 1980's (Birkhead and Nettleship 1987), to a diet dominated by daubed shanny in the late 1990's (R. Bryant, unpublished data).

Other species in this study are less important prey for mammalian and avian predators than capelin and herring, but nevertheless showed important trends in energy density. Northern shrimp showed a significant sexual difference with males having higher energy density than females. There was an increase of ED with body size in several species, notably capelin, Greenland halibut and *Illex* squid. However, the data in this thesis that showed that ED did not increase for most species tested may explain why predators like harp seals eat small prey, or smaller individuals of certain prey species (Beck et al. 1993; Lawson et al. 1995; Lawson and Stenson 1997): there may be no energetic advantage to searching for rare, large prey that are difficult to handle if the energy return from this strategy is not commensurately greater as well. For instance, the digestive efficiency of harp seals is greater when fed small than large Atlantic cod (Lawson et al. 1997), even though the ED of cod is not correlated with its body size (and the ED of cod is relatively similar across locations; Table 9). It is therefore not surprising that most Atlantic cod recovered from harp seal stomachs are smaller individuals. On the other hand, there is greater energy per gram of Greenland halibut as the fish grow larger, yet harp seals eat halibut up to a fork length only slightly larger than the largest Atlantic cod they eat (Figure 3). In this case, studies of feeding behaviour of captive harp seals have shown that prey handling time and effort increases significantly with body size in haibut (J. Lawson, Ocean Sciences Centre, Memorial University, St. John's, Newfoundland; unpublished data).

ED of squid in this study, particularly *Gonatus*, was higher than reported previously (but see Perez 1994), because the entire animal was analyzed, rather than just the muscular, low-fat mantle (e.g., Croxall and Prince 1982). This suggests that more analyses of cephalopods and other invertebrate prey are warranted by ecologists studying predators which consume these prey types.

Interannual differences in ED of prey may be great (e.g., Martensson et al. 1996). For example, Nilssen et al. (1994) reported significant changes in the liver index of prespawning cod in Lofoten during 1947 to 1988. In addition to the interannual changes in ED reported for herring and halibut in this study, several other studies of fish in the Atlantic have shown long-term changes in body condition (Shelton et al. 1996; Lambert and Dutil 1997) or size-at-age (Hansen 1987). This will have significant impacts on the consumption rates, and perhaps prey choice, of many predators, and should be examined more closely, particularly for important prey species such as herring and capelin. Seasonal variation in PC has been linked to changes in primary production (Mårtensson et al. 1996). The water content of fish changes with season and reproductive state: groundfish contain a higher percentage of water after spawning (Woyewoda et al. 1986)

Failure to account for the apparent variation in the ED of the prey of marine predators will have significant implications for estimates of total consumption based on energy demand models. For instance, a recent consumption model for harp seals did not consider seasonal or annual changes in ED for most of the species considered (Stenson et al. 1995). Given the apparent seasonal variability in ED for prey such as capelin and herring, which can be more profound than interspecific differences, models which do not account for this may be too simplistic to adequately estimate predator consumption of prey stocks (e.g., Nordøy et al. 1995).

Measures of prey quality are critical inputs to bioenergetic models of predator consumption. Some species that are important components of northwestern Atlantic predator diets undergo significant seasonal and geographic variation in ED. Thus, the accuracy of consumption estimates based on energy requirement models will be reduced if these changes in prey quality are not considered, as is the case for most published models. Since the total energy requirements of large predator populations such as certain seabirds and cetaceans, or harp seals are large, relatively small changes in prey quality may have substantial affects on consumption estimates. In addition, it is clear from comparisons of the results of this study and published descriptions of predator diets that predators may not be choosing prey strictly on the basis of their energy yield. Temporal and spatial dissimilarity in abundance for different prey species may be of equal importance to prey quality. Also, while difficult to obtain, particularly in the field, observational data on the behaviour of fish and the handling mechanics of predators should be considered. Harp seals eat small Greenland halibut (Lawson et al. 1995), although this study showed that larger fish have significantly higher ED. Perhaps harp seals do not eat the larger fish as they are more difficult to capture (usually living in deeper waters than the juveniles; Appendix A), or to consume (greater handling time to render the large fish into pieces that can be swallowed).

Information on diets of vertebrate predators in the northwestern Atlantic and the results of this study indicate that predators are not necessarily choosing prey based on their energy requirement. Long-term information about changes of ED in different prey items would be helpful, but the present study suggests that future work should be carried out on other prey species, particularly juvenile age classes.

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Table 1. Number of prey collected from nearshore and offshore waters of Newfoundland and Labrador in 1991 to 1996, subdivided by collection area. Mean prey length ± 1 SD for each sample block is shown in parentheses. Lengths are standard length for plaice, fork length for all other fish, carapace length for shrimp, and mantle length for squid. Sum.: summer; Win.: winter.

	Labrador		NE Newfoundland	E Newfoundland		S Newfoundland	Sum. [a]	Win. [b]	Total
Species	Nearshore	Offshore	Offshore	Nearshore	Offshore	Nearshore			
Atlantic cod (*Gadus morhua*)	82 (18.1±4.94)			24 (27.8±10.8)			106		106
American plaice (*Hippoglossoides platessoides*)				24 (27.3±4.58)		13 (18.6±2.84)	24	13	37
Sand lance (*Ammodytes dubius*)			16 (18.1±1.89)		28 (17.9±1.61)		28	16	44
Arctic cod (*Boreogadus saida*)	11 (14.3±1.43)	5 (11.3±1.07)	17 (18.1±4.17)	16 (18.5±2.07)	30 (14.6±2.12)		11	68	79
Northern shrimp (*Pandalus borealis*)			33 (2.29±0.96)					33	33
Redfish (*Sebastes* spp.)				5 (21.3±2.23)		49 (21.9±6.99)		54	54
Greenland halibut (*Reinhardtius hippoglossoides*)					48 (22.5±6.67)			48	48
Daubed shanny (*Lumpenus maculatus*)	16 (14.2±0.94)						16		16
Squid (*Illex illescebrosus*)				32 (34.0±3.93)			32		32
Squid (*Gonatus fabricii*)		47 (8.46±1.96)					47		47
Capelin (*Mallotus villosus*)	2 (14.8±0.21)				82 (14.0±1.09)		33	51	84
Atlantic herring (*Clupea harengus*)				40 (28.4±3.11)			5	35	40
Total	111	52	66	141	188	62	291	329	620

[a] April to September [b] October to March

Table 2. Proximate composition of prey species. Mean (SD) moisture, lipid, protein, inorganic and energy density (ED) for the 12 species studied. Values are expressed for wet mass

Species	Mass (g)	Standard Length (cm) [a]	% Moisture content	% Lipid content	% Protein content	% Inorganic content	Energy density (kJ g^{-1})
Atlantic cod	131 (184.5)	20.2 (7.85)	78.5 (2.17)	2.6 (1.19)	16.1 (1.68)	2.9 (0.47)	4.2 (0.60)
American plaice	153 (104.3)	24.2 (5.57)	78.2 (1.96)	3.0 (1.14)	15.6 (1.61)	3.1 (0.56)	4.3 (0.46)
Sand lance	15.1 (3.30)	17.9 (1.70)	77.9 (2.69)	2.9 (1.88)	16.7 (1.52)	2.5 (0.51)	4.4 (0.82)
Arctic cod	36.6 (20.44)	15.9 (3.36)	78.9 (2.47)	3.7 (1.60)	15.0 (1.84)	2.3 (0.39)	4.4 (0.77) [b]
Northern shrimp	11.5 (2.04)	2.3 (0.10)	74.6 (1.90)	3.6 (0.85)	17.2 (1.26)	4.6 (0.41)	4.8 (0.51)
Redfish	204 (143.8)	21.9 (6.68)	74.4 (1.99)	6.0 (1.93)	16.0 (1.77)	3.8 (0.76)	5.4 (0.83) [b]
Greenland halibut	84.4 (55.98)	22.6 (6.71)	78.1 (2.40)	7.5 (2.25)	12.2 (1.06)	2.2 (0.40)	5.5 (1.13) [b]
Daubed shanny	11.6 (1.99)	14.3 (1.01)	72.2 (6.14)	5.0 (1.67)	19.9 (4.33)	2.9 (0.65)	5.9 (1.38)
Squid (*Illex*)	136 (35.6)	34.0 (3.93)	75.1 (1.45)	6.6 (1.55)	17.0 (0.65)	1.4 (0.14)	5.9 (0.56)
Squid (*Gonatus*)	22.0 (13.81)	8.5 (0.20)	73.5 (5.95)	10.9 (3.80)	13.7 (2.70)	1.9 (0.56)	6.9 (1.76)
Capelin	19.4 (4.92)	14.0 (1.09)	68.2 (10.06)	13.7 (7.87)	16.1 (4.97)	2.1 (0.44)	8.4 (3.28) [b]
Atlantic herring	280 (85.7)	28.2 (3.13)	65.0 (3.43)	13.7 (3.90)	20.1 (1.28)	0.8 (0.07)	9.4 (1.40)

[a] Fork length for fish (except standard length for American plaice), carapace length for shrimp, and mantle length for squid

[b] Value is an average of 2 samples of significantly different energy density

Table 3. Summary of significant differences in ED among species, as determined by Scheffé's tests following one-way ANOVAs. ED increases from left to right (and bottom to top). (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$).[a]

	Atlantic cod	American plaice	Sand lance	Arctic cod	Northern shrimp	Redfish	Greenland halibut	Daubed shanny	Squid (*Illex*)	Squid (*Gonatus*)	Capelin	Atlantic herring
Atlantic cod						*	* *		* *	* * *	* * *	* * *
American plaice										* * *	* * *	* * *
Sand lance										* * *	* * *	* * *
Arctic cod									*	* * *	* * *	* * *
Northern shrimp										* * *	* * *	* * *
Redfish										*	* * *	* * *
Greenland halibut											* * *	* * *
Daubed shanny											* * *	* * *
Squid (*Illex*)											* * *	* * *
Squid (*Gonatus*)											* *	* *
Capelin												

[a] $F[11,608] = 61.8$, $P < 0.0001$.

Table 4. Summary of significant differences in per cent protein (arcsine-transformed) among species, as determined by Scheffé's tests following one-way ANOVA. Protein values increase from left to right (and bottom to top). (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$).[a]

	Squid (*Gonatus*)	Arctic cod	Redfish	American plaice	Atlantic cod	Capelin	Sand lance	Squid (*Illex*)	Northern shrimp	Atlantic herring	Daubed shanny
Greenland halibut		***	***	***	***	***	***	***	***	***	***
Squid (*Gonatus*)			**		***	***	***	***	***	***	***
Arctic cod									*	***	***
Redfish										***	**
American plaice										***	***
Atlantic cod										***	***
Capelin										***	**
Sand lance										**	
Squid (*Illex*)											
Northern shrimp											
Atlantic herring											

[a] $F_{[11,608]} = 25.9$, $P < 0.0001$.

Table 5. Summary of significant differences in per cent ash (arcsine-transformed) among species, as determined by Scheffé's tests following one-way ANOVAs. Ash values increase from left to right (and bottom to top). (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$).[a]

	Squid (*Illex*)	Squid (*Gonatus*)	Capelin	Greenland halibut	Arctic cod	Sand lance	Daubed shanny	Atlantic cod	American plaice	Redfish	Northern shrimp
Atlantic herring		* * *	* * *	* * *		* * *	* * *	* * *		* * *	* * *
Squid (*Illex*)		* *	* * *	* * *	* * *	* * *	* * *	* * *		* * *	* * *
Squid (*Gonatus*)						* *	* * *	* * *		* * *	* * *
Capelin						*	* *	* * *		* * *	* * *
Greenland halibut							* *	* * *		* * *	* * *
Arctic cod										* * *	* * *
Sand lance										* * *	* * *
Daubed shanny										* *	* * *
Atlantic cod										* * *	* * *
American plaice											
Redfish											

[a] $F[11,608] = 129.8$, $P < 0.0001$.

Table 6. Summary of results from simple linear regressions of ED on body length, for species with N>15.

Species	Locality/Season	Season	Slope (95% CI)	Intercept (95% CI)	r^2	d.f.	*P*
Atlantic herring	E Nfld., nearshore	winter	-0.39 (-0.67, -0.10)	19.7 (11.6, 27.9)	0.18	1, 33	0.01
Capelin	E Nfld., offshore	summer	0.44 (0.19, 0.70)	-1.97 (-5.72, 1.77)	0.31	**1, 29**	0.001
Capelin	E Nfld., offshore	winter	0.48 (0.11, 0.85)	4.07 (-0.96, 9.10)	0.12	**1, 48**	0.01
Squid (*Gonatus*)	Lab., offshore	summer	0.29 (0.13, 0.45)	4.24 (2.84, 5.64)	0.23	**1, 44**	0.001
Squid (*Illex*)	E Nfld., nearshore	summer	0.08 (0.04, 0.13)	3.05 (1.58, 4.51)	0.35	**1, 30**	<0.001
Daubed shanny	Lab., nearshore	summer	-0.20 (-1.04, 0.63)	8.79 (-3.06, 20.63)	0.02	**1, 14**	0.6
Greenland halibut	E Nfld., offshore	winter	0.13 (0.10, 0.16)	2.59 (1.84, 3.34)	0.60	**1, 46**	<0.001
Redfish	S Nfld., nearshore	winter	0.03 (0.00, 0.06)	4.79 (4.07, 5.51)	0.09	**1, 47**	<0.05
Northern shrimp	NE Nfld., offshore	winter	-0.02 (-1.95, 1.91)	4.86 (0.43, 9.29)	~0	1, 31	1.0
Arctic cod	E Nfld., nearshore	winter	-0.07 (-0.15, 0.02)	4.41 (2.84, 5.98)	0.17	1, 14	0.1
Arctic cod	E Nfld., offshore	winter	0.0 (-0.08, 0.08)	4.85 (3.67, 6.03)	~0	1, 28	1.0
Arctic cod	NE Nfld., offshore	winter	-0.08 (-0.14, 0.01)	6.16 (4.96, 7.35)	0.31	1, 15	0.02
Sand lance	NE Nfld., offshore	winter	-0.03 (-0.26, 0.31)	3.69 (-1.47, 8.86)	~0	1, 14	0.8
Sand lance	E Nfld., offshore	summer	-0.07 (-0.25, 0.11)	5.85 (2.60, 9.09)	0.02	1, 26	0.4
American plaice	E Nfld., nearshore	summer	0.05 (0.02, 0.07)	2.98 (2.31, 3.66)	0.43	1, 22	<0.001
Atlantic cod	E Nfld., nearshore	summer	0.05 (0.01, 0.08)	3.12 (2.07, 4.18)	0.24	1, 22	0.01
Atlantic cod	Lab., nearshore	summer	-0.02 (-0.04, 0.00)	4.49 (4.15, 4.83)	0.05	1, 80	<0.05

Table 7. Summary of results from ANOVAs to test for sex differences in ED (in $kJ \bullet g^{-1}$), for species with N>10 for each sex.

Species	Locality	Season	Male mean ± SD (N)	Female mean ± SD (N)	*P*
Capelin	E Nfld., offshore	summer	4.60 ± 0.732 (12)	4.65 ± 0.862 (10)	0.9
Capelin	E Nfld., offshore	winter	11.0 ± 1.71 (30)	10.3 ± 1.60 (19)	0.3
Squid (*Illex*)	E Nfld., nearshore	summer	6.06 ± 0.646 (15)	5.73 ± 0.425 (17)	0.1
Redfish	S Nfld., nearshore	winter	5.45 ± 0.723 (35)	5.88 ± 0.89 (10)	0.2
Northern shrimp	NE Nfld., offshore	winter	5.16 ± 0.526 (11)	4.65 ± 0.415 (22)	$P < 0.01$
Arctic cod	E Nfld., offshore	winter	4.77 ± 0.449 (10)	4.89 ± 0.439 (20)	0.5
Sand lance	E Nfld., offshore	summer	4.57 ± 0.783 (16)	4.56 ± 0.688 (12)	1.0
Atlantic cod	E Nfld., nearshore	summer	4.35 ± 1.120 (12)	4.44 ± 0.907 (12)	0.8
Atlantic cod	Lab., nearshore	summer	4.22 ± 0.383 (24)	4.14 ± 0.425 (23)	0.7

Table 8. Summary of results from ANOVAs on seasonal, geographic, and interannual variation in ED (in $kJ \bullet g^{-1}$), for species with N>15.

Species	Comparison	A Mean ± SD (N)	B Mean ± SD (N)	*P*
Seasonal comparison				
Capelin	A (summer) vs. B (winter) (all E Nfld., offshore)	4.62 ± 0.771 (31)	10.7 ± 1.66 (51)	<0.001
Geographic comparisons				
Arctic cod	A (offshore) vs. B (nearshore) (all E Nfld., winter)	4.85 ± 0.438 (30)	3.19 ± 0.332 (16)	<0.001[a]
Arctic cod	A (E Nfld.) vs. B (NE Nfld.) (all offshore winter)	4.85 ± 0.438 (30)	4.74 ± 0.584 (17)	0.74[a]
Atlantic cod	A (E Nfld.) vs. B (Lab.) (all nearshore summer)	4.40 ± 0.998 (24)	4.16 ± 0.413 (82)	0.09
Mixed seasonal/geographic comparison				
Arctic cod	A (E Nfld., nearshore) vs. B (NE Nfld., offshore) (all winter)	3.19 ± 0.332 (16)	4.74 ± 0.584 (17)	<0.001[a]
Sand lance	A (E Nfld., summer) vs. B (NE Nfld., winter) (all offshore)	4.56 ± 0.731 (28)	4.20 ± 0.938 (16)	0.16
Interannual comparisons				
Greenland halibut	A (January 1992) vs. B (October 1995) (all E Nfld., offshore)	6.56 ± 1.484 (10)	5.28 ± 0.865 (38)	<0.001
Atlantic herring	A (November 1992) vs. B (September & October 1993) (all E Nfld., nearshore)	9.06 ± 0.723 (10)	10.1 ± 0.66 (14)	<0.01

[a] These probability estimates are from Scheffé's test, from one ANOVA on all the Arctic cod samples.

Table 9: Summary of published proximate composition and energy density ($kJ \cdot g^{-1}$ wet mass, unless noted) values for same species as those in this study.

Species	Notes	Year	Season	Location	N	% W	% P	% L	% A	ED	Source
Atlant. cod	Gonad; Immat.	78-79	Mar	Bay Fundy	31	83.76 (0.86)	13.15 (0.77)	1.48 (0.24)	1.60 (0.13)	714 (41) Cal	Holdway & Beamish 84
	Carcass; Immat.	78-79	Mar	Bay Fundy		78.89 (0.22)	16.23 (0.35)	1.89 (0.18)	2.11 (0.08)	930 (13) Cal	Holdway & Beamish 84
	Muscle; Immat.	78-79	Mar	Bay Fundy		79.77 (0.20)	17.32 (0.29)	1.81 (0.18)	1..31 (0.02)	994 (15) Cal	Holdway & Beamish 84
	-	93	Jan-Dec	NE Atl.	16	-	-	-	-	3.9 - 6.1	Mårtensson et al. 96
	-	89	Feb	Norway	-	-	-	-	-	4.18	Wiig 89
Amer. plaice	-	-	-	-	-	-	-	-	-	5.1	Mackinnon 72
	Fillet	-	-	-	-	-	-	0.66	-	-	Krzynowek & Murphy 87
Sand lance	-	-	-	Nfld.		63.5	19.5	8.9	7.3	7.3	Montevecchi et al. 84
	6.1-8.0 cm	86	July	Scotland	06	79.5	77.56 [a]	14.15 [a]	-	-	Hislop et al. 91
	-	86	July - Aug	Labrador	-	-	-	-	-	6.7	Birkhead & Nettleship 87 [d]
Arctic cod	13.2+_1.3 cm	85	Feb	Svalbard	-	72 ± 0.0	15 ± 0.1	10 ± 0.1	-	7.4 ± 0.1	Brekke & Gabrielsen 94
	-	93	Jan-Dec	NE Atl.	6	-	-	-	-	4.4 - 6.3	Mårtensson 96
	Adult			High Arctic	700					6.5 (SE =10.0)	Hop 94 (combined carcass, liver, intestine, gonad)
	Immat.			High Arctic	315					5.6 (SE =10.0)	Hop 94 (whole animals)
	Adult	83	Aug	High Arctic	-	-	-	-	-	5.4	Finley & Gibb 83
	13.2 ± 1.2	89	Feb	Norway	-	-	-	-	-	7.4 ± 0.1	Wiig 89
	9.9 ± 2.2	89	June	Norway	-	-	-	-	-	4.9 ± 0.0	Wiig 89

Table 9: Summary of published proximate composition and energy density ($kJ \cdot g^{-1}$ wet mass, unless noted otherwise) (continued).

Species	Notes	Year	Season	Location	N	% W	% P	% L	% A	ED	Source
Redfish	-	-	-	-	-	78.1	18.4	2.7	-	-	Frimodt 95 (100g tissue) [b]
			Winter					ash-free dry wt		23.1	Steimle & Terranova 85
			Spring					ash-free dry wt		20.1	Steimle & Terranova 85
			Summer					ash-free dry wt		25.8	Steimle & Terranova 85
	-	93	Apr	NE Atl.	1	-	-	-	-	6.7	Mårtensson et al. 96
	-	93	Oct	NE Atl.	1	-	-	-	-	7.9	Mårtensson et al. 96
Gonatus	Mature	-	-	N Atl.	-	75.0	12.5	1.0	1.8	6.27	Kristensen 84
Illex	-	78-79	-	Nfld.	-	78.2	15.9	3.0	1.8	4.3	Montevecchi et al 84 [d]
	Mantle, tent.	76-87		NW Atl.	-	-	1.05	1.85	0.3	≤ 1.8	Krzynowek & Murphy 87
			Winter					ash-free dry wt		24.6	Steimle & Terranova 85
			Summer					ash-free dry wt		22.6	
Capelin	1.0 - 2.10 cm	68	Feb-May	Nfld.	130	69.7-81.3	-	0.8-14.4	-	-	Winters 70
	12.5 - 17.5 cm	75	Mar-July	Nfld.	-	77.1-83.7	-	0.2-8.3	-	-	Eaton et al 75
	-	78-79	-	Nfld.	-	78.4	14.9	3.3	2.0	4.2	Montevecchi et al 84 [d]
	10.4 ± 0.7 cm	85	May	Barents Sea	-	79+-0.1	15 ± 0.5	3 ± 0.1	-	4.1 ± 0.2	Brekke & Gabrielsen 94
	-	-	-	-	-	65.6	13.6	17.5	-	-	Frimodt 95 (100g tissue) [b]
	Ovid female									4.6	Montevecchi & Piatt 87
	Spent female									3.9	Montevecchi & Piatt 87
	Adult male									3.8	Montevecchi & Piatt 87
	Immature									3.8	Montevecchi & Piatt 87
	-	91	Jan-Mar	Barents Sea	5	-	-	-	-	8.6	Mårtensson et al. 94
			Jan-Mar	NE Atl.	5 [c]	-	-	-	-	7.8 ± 1.1	Mårtensson et al. 96
	-	93	Apr-June	NE Atl.	5 [c]	-	-	-	-	5.3 ± 0.5	Mårtensson et al. 96
	-	93	Aug-Sep	NE Atl.	6 [c]	-	-	-	-	7.7 ± 1.4	Mårtensson et al. 96
		89	Feb	Norway						6.3 - 10.0	Wiig 89

Table 9: Summary of published proximate composition and energy density (kJ•g^{-1} wet mass, unless noted otherwise) (continued).

Species	Notes	Year	Season	Location	N	% W	% P	% L	% A	ED	Source
Shrimp	-	-	-	NE Pac.	-	80.1	18.1	0.95	1.25	-	Krzynowek & Murphy 87
	-	71	All year	NW Atl.	-	-	-	-	-	5.4	Cummins & Wuycheck 71 in Lavigne et al. 1985
Green. hal.		-	-	-		70.3	14.4	13.8	-	-	Frimodt 95 (100g tissue) [b]
Atl. herring	Mature	93	Mar	NE Atl.	10	-	-	-	-	7.2	Màrtensson et al. 96 (est.)
	Mature	93	May-Sep	NE Atl.	-	-	-	-	-	11.2	Màrtensson et al. 96
		89	June	Norway	-	-	-	-	-	8.4 - 10.0	Wiig 89
	-	87	Jan-Dec	Scotland	-	-	-	-	-	4.2 - 11.0(?)	Hislop et al 91
	-	-	-	N. S. - N. Carolina	-	57.0			8.0	-	Steimle & Terranova 85

Note: Where ED values were not presented in the original paper (and there were complete PC data on lipid, protein, water and ash content) I calculated ED values based on the same energy equivalents as in this study.

[a] Composition values of protein and fat were calculated from reported wet composition values; dry value = (100 x wet value)/(100 - water content).

[b] Estimates from Frimodt (1995) may be under- or overestimates for whole body as they describe the analyzed body components as "edible weight".

[c] Each of these are subsamples of homogenates created by grinding from 5 to 25 fish.

[d] These were prey obtained from seabirds returning to their nesting areas.

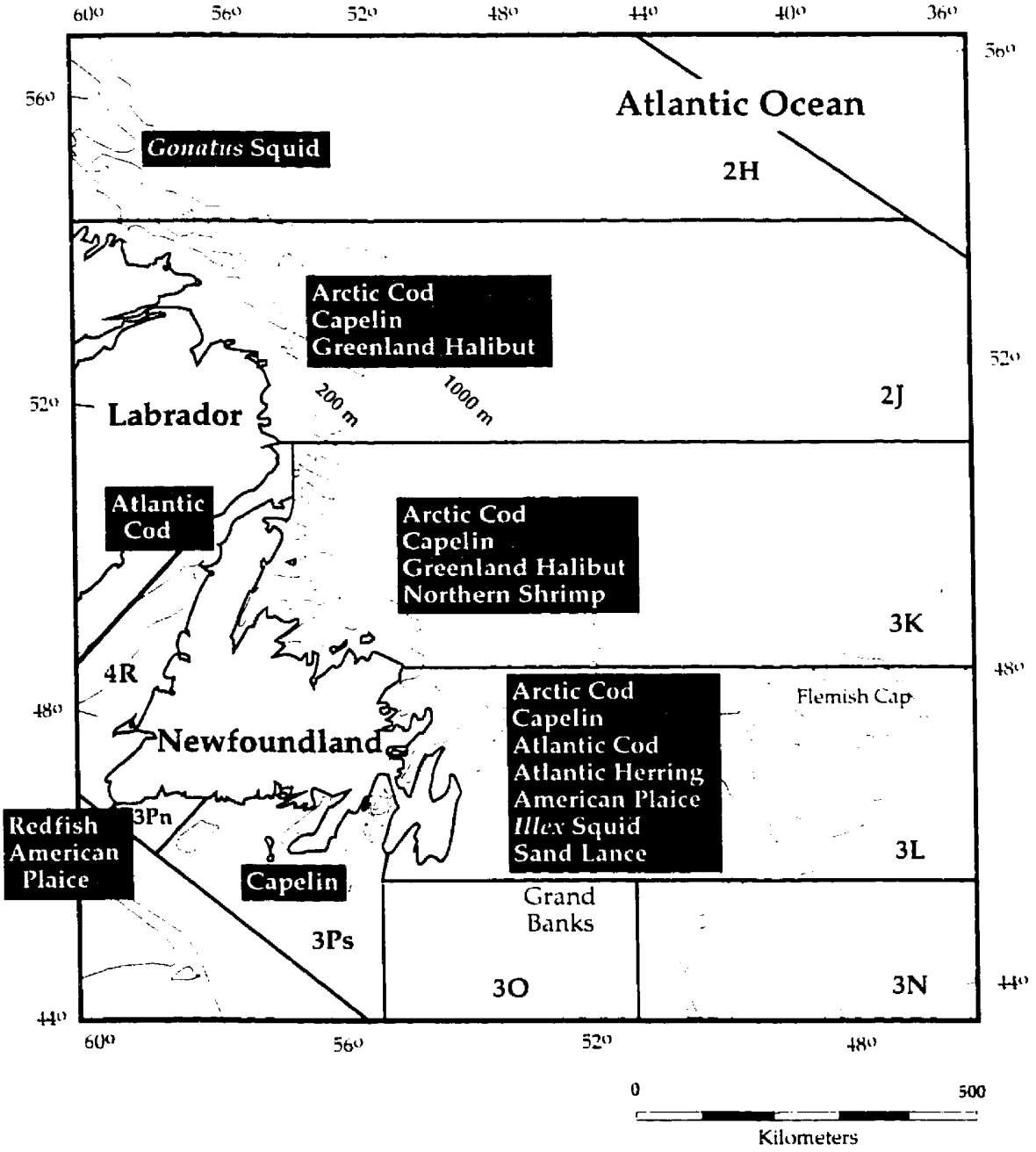

Figure 1: The general locations, subdivided by NAFO fishing areas, where prey samples were collected for this study. Daubed shannies were collected in area 2G (immediately north of this map area).

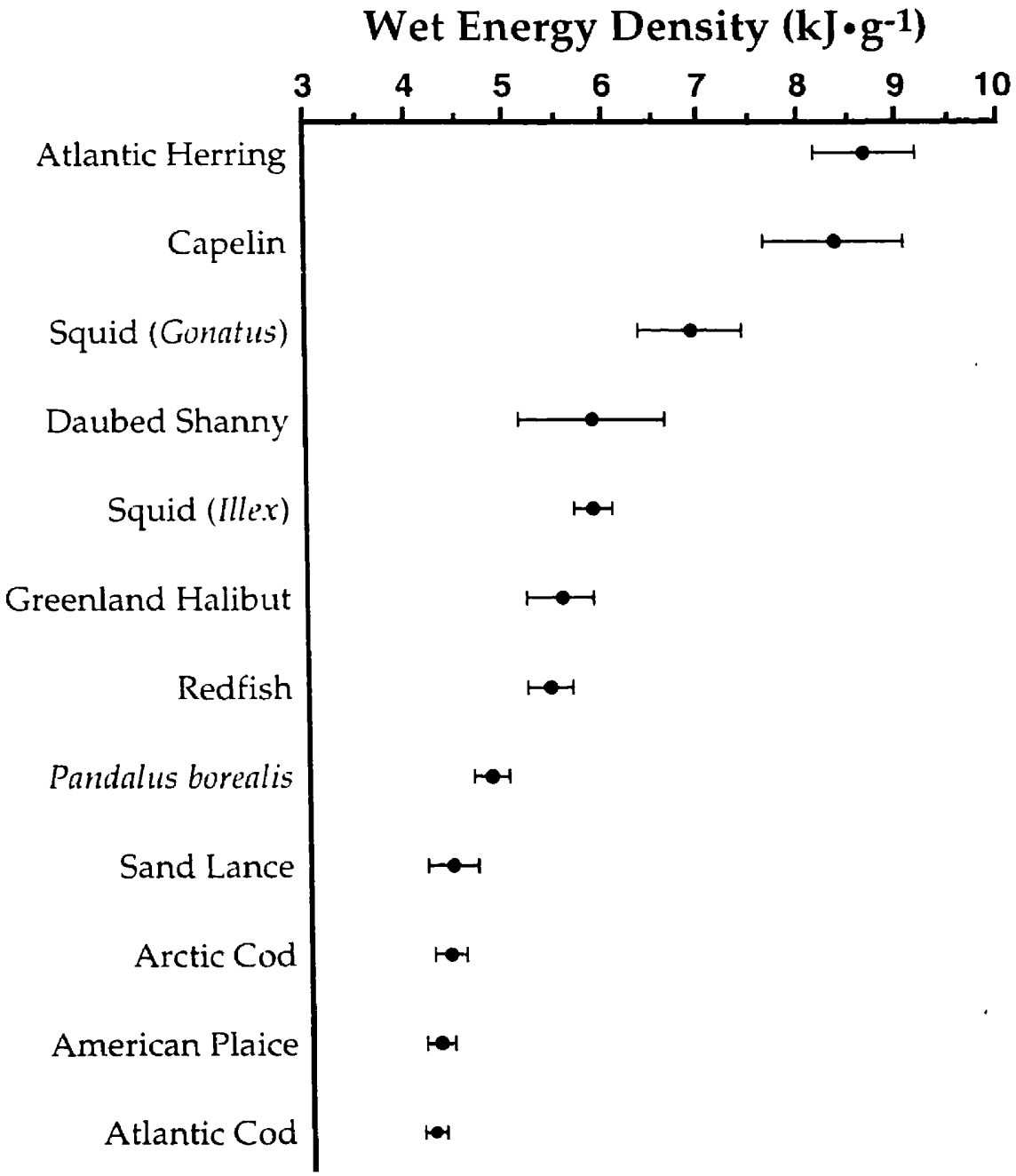

Figure 2: Energy densities (kJ•g^{-1} wet mass) for prey species in this study. Error bars represent the 95% confidence intervals around the mean.

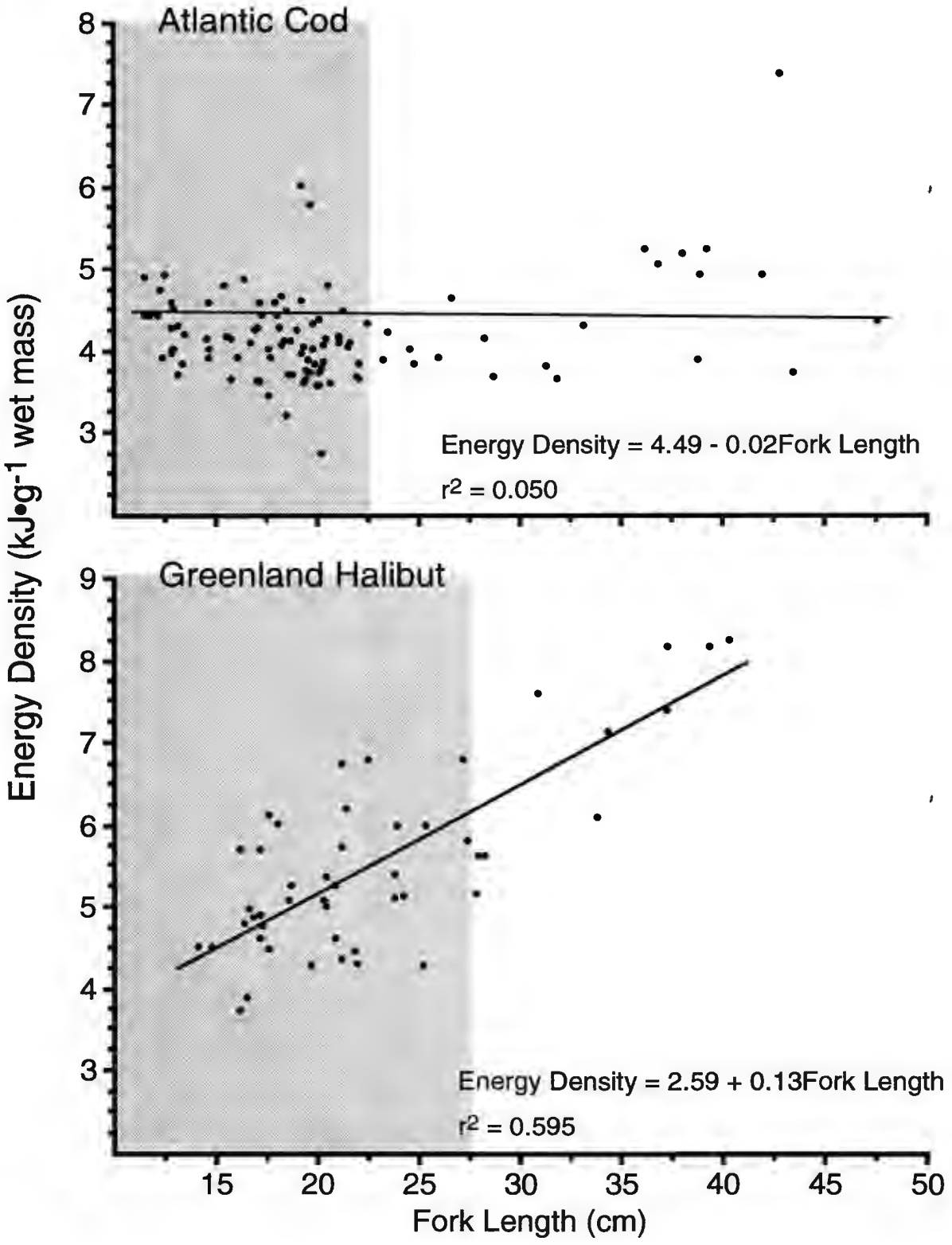

Figure 3: The relationship between prey size and energy density (kJ•g^{-1} wet weight) was weakly negative for Atlantic cod, but strongly positive for Greenland halibut. Size ranges of fish consumed commonly by harp seals are delineated by grey rectangles.

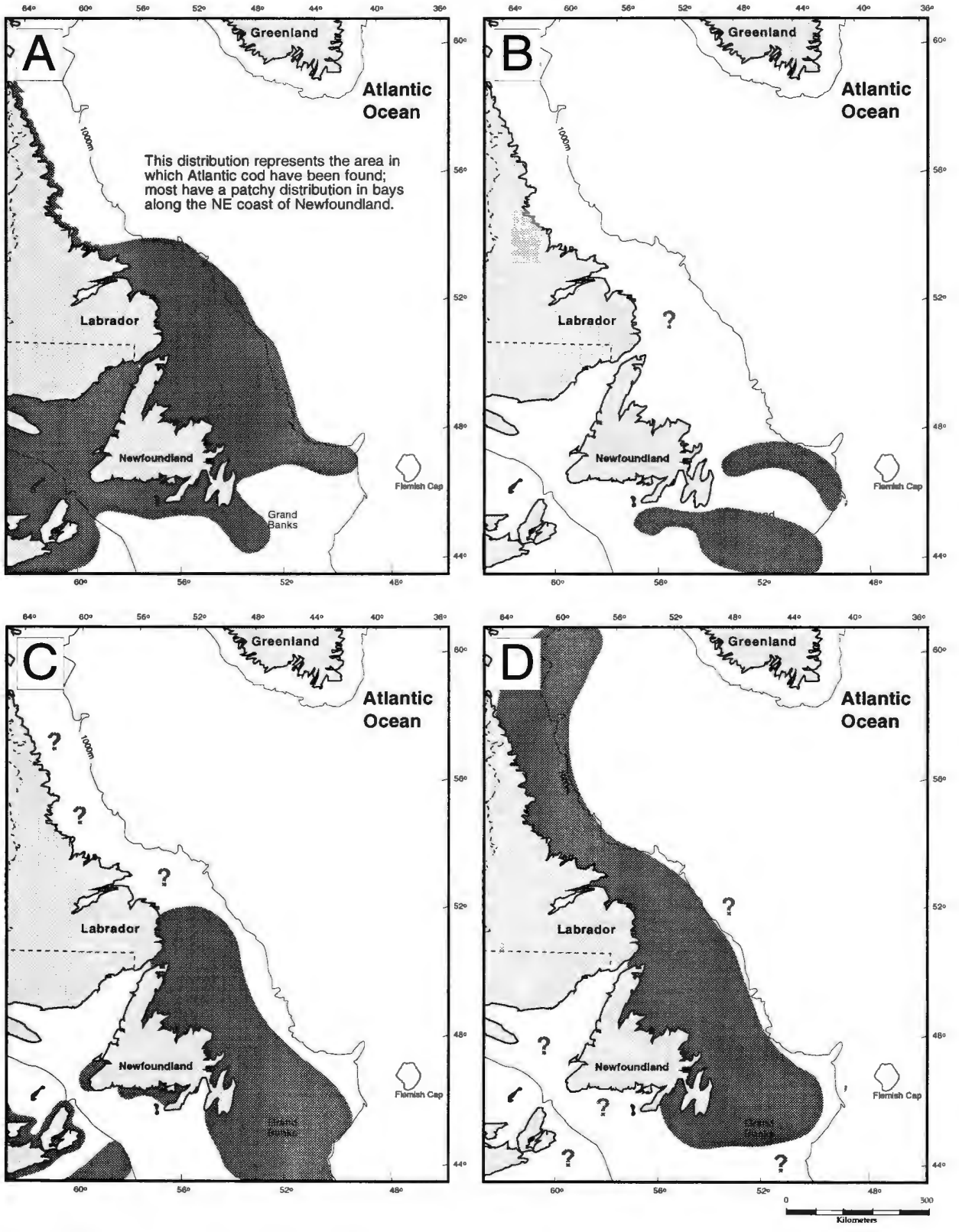

Figure 4: Current geographic distributions of Atlantic cod (A), American plaice (B), sand lance (C) and Arctic cod (D) in the northwest Atlantic.

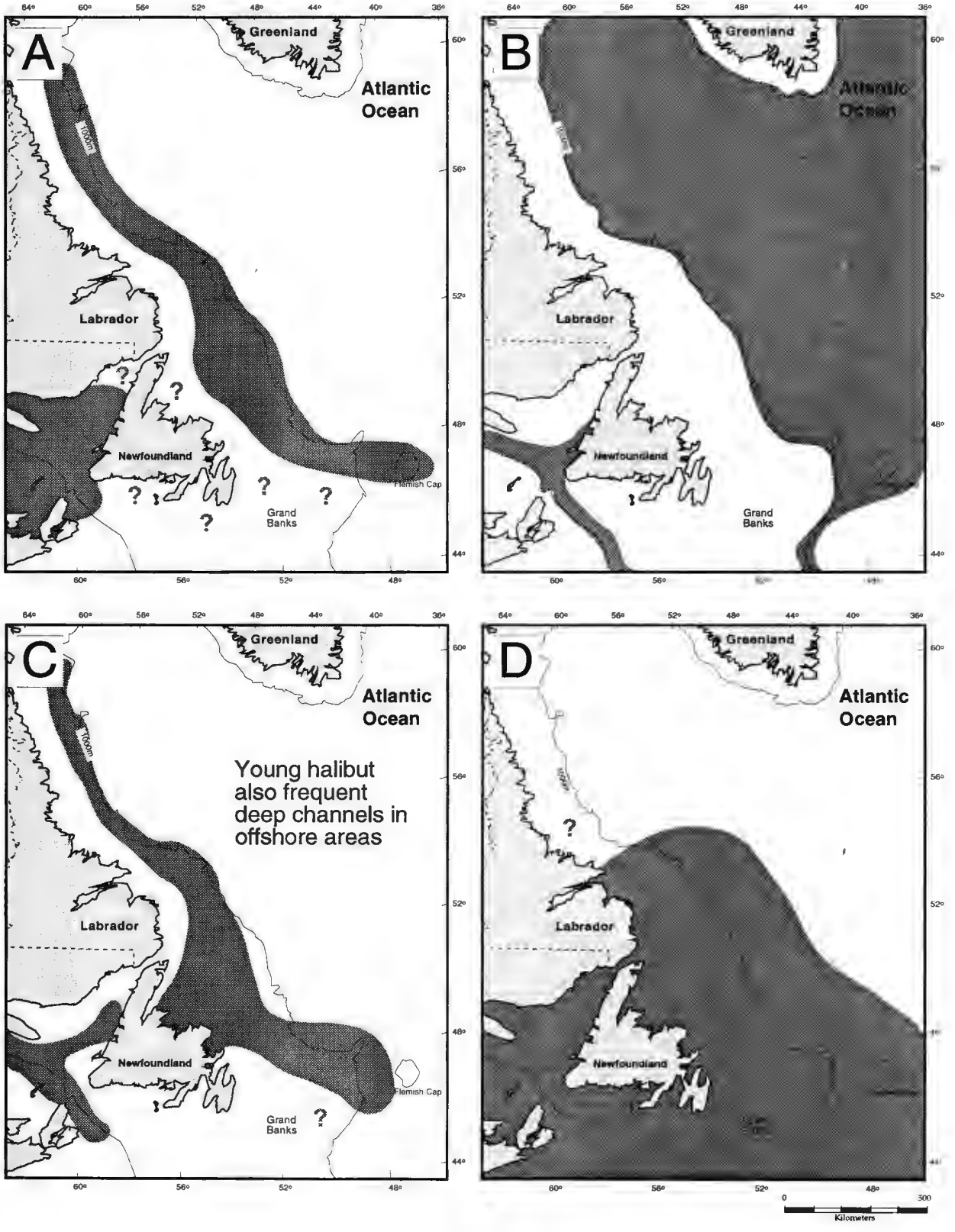

Figure 5: Current geographic distributions of northern shrimp (A), redfish (B), Greenland halibut (C) and *Illex* squid (D) in the northwest Atlantic.

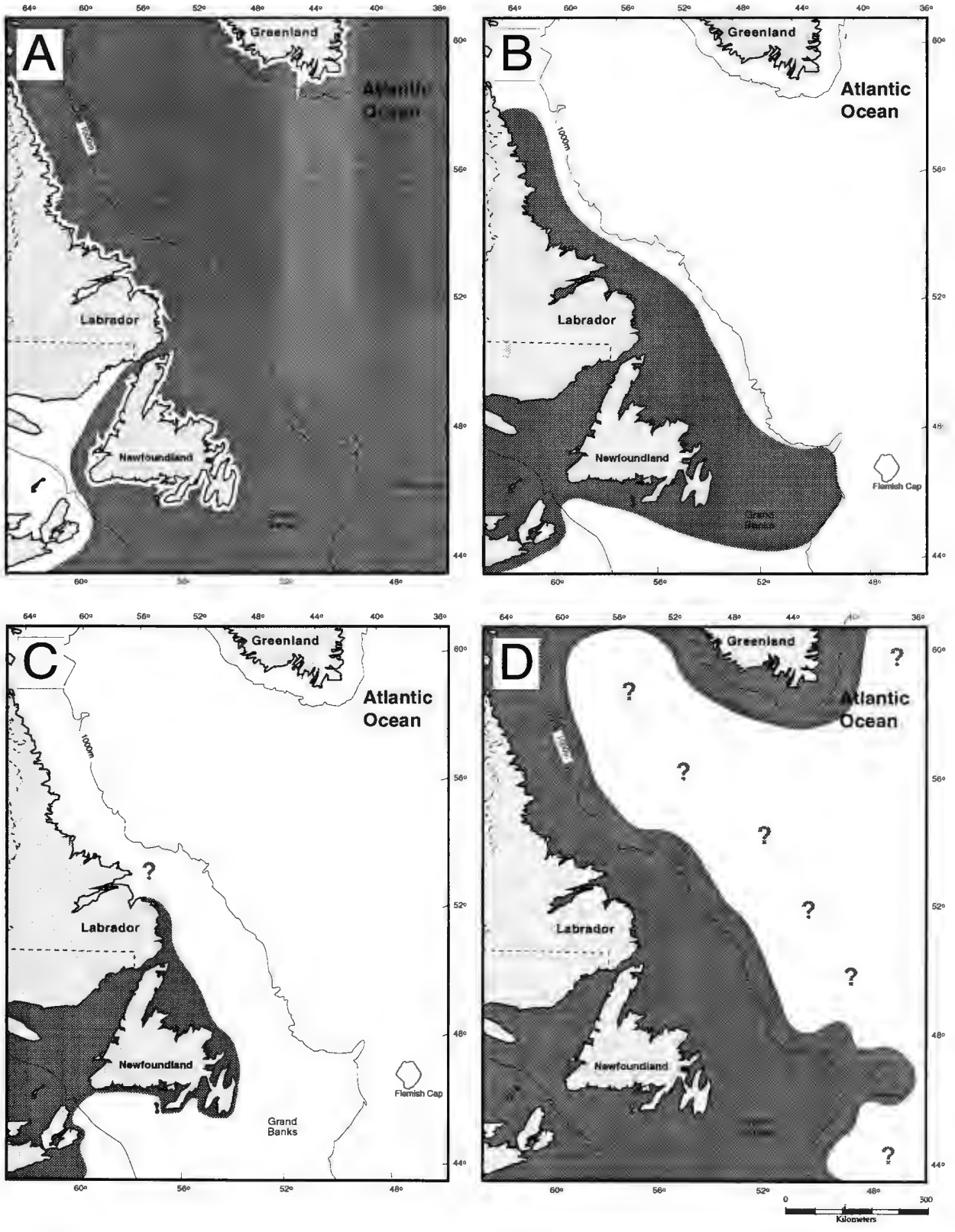

Figure 6: Current geographic distributions of *Gonatus* squid (A), capelin (B), Atlantic herring (C) and daubed shanny (D) in the northwest Atlantic.

Appendix A: Prey Life Histories

1) Atlantic cod (*Gadus morhua*)

Atlantic cod (Figure 4A) [2] were distributed throughout the coastal shelf areas of the northwestern Atlantic from Maine to subarctic areas before the mid 1980s (Pinhorn 1976; Scott and Scott 1988). Since the late 1980s six Canadian stocks, from southern Labrador to the continental shelf of Nova Scotia, have collapsed (Hutchings and Myers 1994; Myers et al. 1996a; 1996b; Myers 1997). The collapse has been documented mainly for fish of commercial size and age (greater than two years old; see Atkinson et al. 1997).

Data on the standing biomass of juvenile Atlantic cod (the size usually found in the stomachs of predators such as harp seals; Lawson and Stenson 1995; 1997; Lawson et al. 1995) is less clear. Whether the availability of these young fish to predators has decreased in parallel with the decline of the spawning biomass is unknown (Myers et al. 1996b). Young fish have been found very close to shore and hence are difficult to survey using traditional methods employed by DFO. Rodway and Montevecchi (1996), indicated that larval and 1-yr-old cod are usually found in the nearshore waters (less than 30 km from shore) of the northwestern Atlantic, while large spawning fish are more likely to be found in offshore areas (greater than

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[2] The current distributions of species described in this Appendix are defined as the areas where they are most commonly found in the northwestern Atlantic. However, in some cases, specimens have been collected outside these areas. The range maps (Figures 4, 5 and 6) are a synthesis of published studies and the technical advice of fisheries scientists from DFO, St. John's, Newfoundland (J. Anderson, J. Brattey, J. Carscadden, E. Dalley, E. Dawe, G. Lilly, D. Miller, M. Morgan, and D. Power) and Memorial University of Newfoundland (J. Brown, J. Lawson, and B. Montevecchi).

30 km from shore). At present, most small cod live in nearshore areas around Newfoundland (Dalley and Anderson 1997).

Atlantic cod are opportunistic predators; when young they feed mostly on small crustaceans (Scott and Scott 1988). As adults they prey on young cod and a variety of other fish species such as capelin, sand lance, short-finned squid and northern shrimp (e.g., Lilly 1984; Lilly and Osborne 1984; Lilly and Parsons 1991).

Atlantic cod, particularly juvenile fish, are prey for marine mammals and birds in the northwestern Atlantic. They are the second most common prey of grey seals (*Halichoerus grypus*) near Sable Island, Nova Scotia (Bowen and Harrison 1994). However, Atlantic cod represent a small fraction of the diet of harp seals (Lawson and Stenson 1995; Lawson et al. 1995). Further, most Atlantic cod, Atlantic herring and capelin consumed by harp seals are smaller than those taken by commercial fisheries (between 10 and 20 cm). Hooded seals (*Cystophora cristata*) consume larger cod than harp seals (Lawson and Stenson, unpublished data; Ross 1993). Atlantic cod is also consumed by Atlantic puffins (Fratercula arctica), common murres, and gannets (*Sula bassanus*) in the northwestern Atlantic (Piatt and Nettleship 1985; Montevecchi and Myers 1996).

2) American plaice (*Hippoglossoides platessoides*)

In the late 1970s, American plaice (Figure 4B) was one of the most important and abundant flatfish of the northwestern Atlantic fishery, formerly occurring from western Greenland to the Gulf of Maine (Pinhorn 1976). However, the commercial stocks around Newfoundland and Labrador (NAFO divisions 2HJ, 3KL and 3Ps) have declined since the late 1980s and expectations for the recovery of commercial stocks are not optimistic (Cairns et al. 1990).

Walsh (1991) reported that juvenile and adult American plaice are found in the shelf edges of the Grand Banks, with a group of predominantly juvenile fish in the southern extend of their range. Walsh (1991) suggested that this concentration of juvenile plaice is evidence of a nursery area. Since juvenile fish are found in the same area as adults, this also suggests that the American plaice is not a migratory species.

American plaice inhabit depths of 90 to 250 m (Bowering and Brodie 1991) and are common at depths of less than 250 m in the northwestern Atlantic (Anonymous 1995a). During winter they migrate to deeper waters, then return to shallow waters the following spring, when spawning occurs (Powles 1965; Scott and Scott 1988).

American plaice feed on benthic organisms. Powles (1965), studying the ecology of this species in the Magdalen Island shallows (NAFO division 4T), found that juvenile and adult plaice have different dietary preferences: juvenile diet was mainly polychaetes and small crustaceans, and adults fed on molluscs and echinoderms. Pitt (1973) reported similar result for American plaice on the Grand Banks. Other studies indicate that adults feed mainly on fish, including sand lance and capelin (Winters 1983; Zamarro 1992).

Plaice are prey for groundfish such as Atlantic cod and Greenland halibut (Scott and Scott 1988), and pinnipeds such as grey (Bowen et al. 1993) and harp seals (Lawson and Stenson 1995; Lawson et al. 1995; Wallace and Lawson 1997).

3) Sand lance (*Ammodytes dubius*)

Sand lance is an important prey species in northern seas (Frimodt 1995). In the northwestern Atlantic it occurs from Greenland to the Scotian Shelf (Scott and Scott 1988), although it is not commercially exploited in Newfoundland and Labrador waters (Pinhorn 1976; Dalley and Winters 1987). Sand lance is a semi-demersal

species in sandy-bottomed and shallow water, usually less than 90 m deep (Figure 4C; Scott 1985; Nelson and Ross 1991).

Two species of sand lance are found in the northwestern Atlantic: *A. dubius* is considered the offshore species and *A. americanus* the nearshore (Winters 1983; Dalley and Winters 1987; Brêthes et al. 1992). The presence of two species is probably the reason for the two main spawning areas in the northwestern Atlantic: the banks (Grand Bank, St. Pierre Bank), and inshore bays. Dalley and Winters (1987), reported the presence of sand lance larvae in Fortune Bay, Newfoundland from February until July and August. Rodway and Montevecchi (1996) also found significant numbers of larval sand lance in the diet of Atlantic puffin (*Fratercula arctica*) chicks on Great Island, Newfoundland in the summers of 1992 to 1994.

Sand lance is an important item in the diet of many fish, sea birds and marine mammals. For instance, Atlantic cod, Atlantic herring, American plaice (Lilly 1982; Winters 1983; Dalley and Winters 1987; Nelson and Ross 1991), short-finned squid (Dawe and Beck 1997); common murres and Atlantic puffins (Birkhead and Nettleship 1987; Rodway and Montevecchi 1996); humpback whale (*Megaptera novaeangliae)* and fin whales (*Balaenoptera physalu*; Overholtz and Nicolas 1979; Piatt et al. 1989); harbour seal (*Phoca vitulina*), harp and grey seals (Pierce et al. 1990; Bowen et al. 1993; Bowen and Harrison 1994; Lawson et al. 1995;) are known to eat sand lance.

4) Arctic cod (*Boreogadus saida*)

The Arctic cod is a pelagic species distributed from the Arctic, including Hudson Bay, to Labrador and Newfoundland (Figure 4D; Pinhorn 1976; Scott and Scott

1988). They are an important trophic link between zooplankton and marine mammals, seabirds and fish in Arctic waters (Welch et al. 1993).

According to (Lilly et al. 1994), there have been changes in Arctic cod abundance in southern Labrador and northeastern Newfoundland waters in the last decade. Lilly et al. (1994) hypothesized that the changes may be related to changes in the distribution and abundance of predators (e.g., Atlantic cod and harp seals), and competitors (e.g., capelin).

The spawning period of Arctic cod is not known for the northwestern Atlantic, nevertheless, Craig et al. (1982) collected "probable spawners" in early winter on Beaufort Sea coastal waters. Similarly, Scott and Scott (1988) suggested that Arctic Eurasian populations spawn from December to March.

The vertical distribution of this species varies, although it is considered as a pelagic species rather than a demersal one (J. Anderson, Department of Fisheries and Oceans, St. John's, Newfoundland personal communication). It is presumed that younger fish (less than 3 years old) are found in shallower waters (Finley et al. 1990).

Arctic cod is an abundant and energetically rich prey item in the high Arctic (Finley et al. 1990). It is considered to be a key species in the Arctic ecosystem due to its significant contribution in the diet of other fish, marine mammals and seabirds (Craig et al. 1982). Arctic cod form large aggregations in nearshore waters, where they are fed on by seabirds such as black-legged kittiwakes (*Rissa tridactyla*), thick-billed Murres (*Uria lomvia*), northern fulmars (Birkhead and Nettleship 1987; Welch et al. 1993), as well as bearded (*Erignathus barbatus*), harp, hooded and ringed seals (*Pusa hispida*; Finley and Evans 1983; Finley et al. 1990; Ross 1993) and narwhals (*Monodon monoceros*) and beluga (*Delphinapterus leucus*; Bradstreet and Cross 1982; Welch et al. 1993). In recent years seals have been seen feeding on schools of Arctic

cod during winter around bays of the Avalon Peninsula, Newfoundland (J. Lawson, Ocean Sciences Centre, Memorial University, St. John's, Newfoundland, personal communication). Arctic cod was the most important prey item in the diet of harp seals from 1986 to 1995 in the northwestern Atlantic (Lawson and Stenson 1995; Lawson et al. 1995).

5) Northern shrimp (*Pandalus borealis*)

The northern shrimp is widely distributed in the northwestern Atlantic from the Davis Strait to the Gulf of Maine (Figure 5A; Squires 1990). Commercial landings suggest that *Pandalus* is abundant in NAFO divisions 0B, 2G and 3K (Parsons and Veitch 1996). Moreover, catches have increased in the estuary and Gulf of St. Lawrence in 1994 and 1995 (Savard 1996). Since the abundance of predators of northern shrimp such as Atlantic cod, redfish and Greenland halibut have declined, the abundance of *Pandalus* in some areas of the northwestern Atlantic may have increased.

Pandalus is hermaphroditic; it spends the first stage of its life as a male, then changes sex to reproduce. Parsons et al. (1991) reported *Pandalus* in depths over 350 m off Labrador and northeastern Newfoundland. However, this distribution varies with age and size. For example, young shrimp are found in shallower water, while adults (usually females) are in the deeper waters off the continental shelf. At the end of the fall and beginning of winter, ovigerous females migrate to shallower waters. They release the larvae in the spring before returning to deep waters.

Atlantic cod stomachs collected in the NAFO divisions 2H, 2J and 3K have contained *Pandalus*, with young shrimp in the same areas and depths as larger shrimp (Lilly and Parsons 1991). The northern shrimp is also an important prey in

the diet of other fish, including Greenland halibut off the Labrador coast (Bowering et al. 1984), redfish on the Flemish Cap (Albikovskaya and Gerasimova 1989) and herring on the Scotian Shelf (Anonymous 1996c). Lawson et al. (1995) showed the prevalence of *Pandalus* in the diet of harp seals, particularly in 1992, is due to a relative decline in their consumption of Arctic cod.

6) Redfish (*Sebastes* spp.)

Redfish, also called ocean perch, has a wide distribution in the northern Atlantic. In the northwestern Atlantic the distribution extends from the southern coast of the Baffin Island to New Jersey (Figure 5B). Three of the four species of redfish are in the northwestern Atlantic. However, the similarity of their morphological characteristics make the process of identification difficult (Ni and Templeman 1985; Frimodt 1995).

The abundance of redfish in Newfoundland waters has decreased since the early 1970s (Pinhorn 1976). Recently, Power (1995) reported that the commercial stock, in the same area reported by Pinhorn in the late 1970s, is now at an extremely low level. Since this species has a slow growth rate and reaches maturity at eight years of age, continued fishing may threaten the remaining populations.

Redfish are pelagic, occurring in cold and deep waters and living as long as 80 years (Power 1995). Bainbridge (1971) observed the distribution of redfish larvae in different areas of the northwestern Atlantic, characterizing the occurrence of different spawning areas. In April, larvae were found around the Flemish Cap, in June off Labrador and northeast coast of Newfoundland, and in July off Nova Scotia and the Gulf of Maine. Similarly, Ni and Templeman (1985), found that most spawning of redfish in southern Newfoundland waters took place from April to July.

Redfish feed on pelagic crustaceans such as amphipods, copepods and euphausiids (Lilly 1987; Scott and Scott 1988). They are themselves prey for Atlantic cod and Greenland halibut (Bowering and Lilly 1992), short-finned squid (E. Dawe, Department of Fisheries and Oceans, St. John's, Newfoundland, personal communication), and harp and hooded seals (Ross 1993; Lawson et al. 1995), and harbour porpoise (*Phocoena phocoena*) in the northern Gulf of St. Lawrence (Fontaine et al. 1994).

7) Greenland halibut (*Reinhardtius hippoglossoides*)

Greenland halibut, also known as turbot, is found through the northwestern Atlantic from Davis Strait to the south of the Scotian Shelf (Figure 5C). Individuals from this area form a single biological stock, spawning during winter or early spring in the deep waters of Davis Strait (Bowering and Brodie 1991). Eggs and larvae are carried by currents to the south, where juveniles remain to grow until near maturity, when they migrate back to the north (Scott and Scott 1988). For this reason, most of the Greenland halibut found in Labrador (Hawke Channel) and northeastern Newfoundland waters (Funk Island Bank) can be considered to be young (M.J. Morgan, Department of Fisheries and Oceans, St. John's, Newfoundland personal communication).

The other commercial stock of Greenland halibut is concentrated in the Gulf of St. Lawrence, where individuals are found in depths of 200 to 500 m. This population also spawns between the winter and early spring in the deep waters of the Laurentian Channel, and young Greenland halibut (greater than 45 cm) are found close to the Scotian shelf (Anonymous 1996b; Morin 1996).

Pinhorn (1976) reported the onset of commercial stock depletion in the late 1960s, as well as high exploitation rates in the deep bays of nearshore Newfoundland (Notre Dame and Trinity Bay). Bowering et al. (1996) noted a decline in abundance of commercial stocks in divisions 2J and 3K since the middle 1980s. However, young Greenland halibut (age 1 to 5) were more frequent in catches of 1995 and 1996 in the same area. Few data are available regarding fish under 20 cm in length (see Morin 1996).

The Greenland halibut is an opportunist predator, consuming a variety of cephalopods, crustaceans and fishes. Juvenile diet is comprised of shrimp, cephalopods and small fish, while adults prey on juvenile Greenland halibut, Atlantic cod, capelin, redfish and other demersal fishes (Scott and Scott 1988; Bowering and Lilly 1992).

Greenland halibut are prey for a number of fish, pinnipeds and cetaceans. Atlantic cod and salmon eat Greenland halibut larvae and young fish (W.R. Bowering unpublished data). Lawson et al. (1995) noted that Greenland halibut is an important item in the diet of harp seals in nearshore Labrador. According to Ross (1993), Greenland halibut is one of the main species in the diet of hooded seals in nearshore Newfoundland. Sergeant (1966) reported the occurrence of Greenland halibut in the diet of sperm whales (*Physeter catodon*) in Newfoundland and Labrador.

8) Short-finned squid (*Illex illecebrosus*)

Illex (short-finned squid) is a pelagic cephalopod species, distributed in the northwestern Atlantic from coast of Labrador and Newfoundland to Florida (Black and Rowell 1987). From spring to fall they occur along the Newfoundland coast, when the temperature of the ocean starts to increase (Amaratunga 1981). In the

winter, their distribution is unknown, but it is hypothesized that they either migrate to deeper waters to spawn or move south to the warmer waters of the Gulf Stream (Dawe and Beck 1985).

The short-finned squid is thought to be a migratory species (e.g., Black and Rowell 1987; Dawe and Beck 1997). Spawning may occur from January-February in the south, then eggs masses are transported by the Gulf Stream to the coast of Newfoundland and Labrador, where young individuals concentrate during summer (Dawe and Beck 1985). Finally, at the end of fall, adults again migrate south to spawn, completing their life cycle.

Dawe and Beck (1997) reported different types of prey in the diet of *Illex* collected in nearshore areas of Newfoundland. The diet changed according to locality, year and season of collection. Atlantic cod, sand lance, Arctic cod and capelin were the main prey. Adult short-finned squid appear to be active predators with their diet varying according to the availability of prey in the area. For instance, C. Myers (unpublished data) identified herring and mackerel (*Scomber scombrus*) as the main prey of *Illex* in Nova Scotia and New Brunswick nearshore waters. Additionally, Boyle (1983) reported that *Illex* are a cannibalistic species.

Illex are important prey for Atlantic cod, mackerel, redfish, witch flounder (*Glyptocephalus cynoglossus*), long-finned pilot whales (*Globicephala melaena*), white-sited dolphin (*Lagenorhynchus acutus*), greater and sooty shearwaters (*Puffinus gravis* and *P. griseus*), fulmars and northern gannets (Boyle 1983; Montevecchi 1993). Short-finned squid are consumed by harp seals, particularly during summer in Divisions 2J and 3KL (Lawson et al. 1995). Bowen et al. (1993) also report *Illex* in the stomachs of grey seals on the Scotian Shelf.

9) Arctic squid (*Gonatus fabricii*)

Gonatus fabricii is the most common squid species in offshore waters of the Arctic and subarctic. They occur especially in west Greenland, where they are important as prey for fish, marine mammals and seabirds (Figure 6A; Boyle 1983).

Two populations of *Gonatus* in west Greenland show different breeding peripds. The population of Disko Bugt spawns in the fall and early winter, while the population of Davis Strait spawns in the spring and early summer. Larvae and juveniles were frequently found in 70 to 80 m, while adults inhabit depths of 200 to 600 m. Spawning is presumed to occur in the deep offshore waters of west Greenland (Kristensen 1984).

Gonatus appear to feed mainly on crustaceans, fish and other cephalopods (Kristensen 1984). Juveniles and adults seem to have different diet preferences. Juveniles consume smaller species such as euphausiids, whereas a common prey found in adult stomachs was capelin. This supported Kristensen's opinion that this species of squid feeds pelagically.

Gonatus occur in the diets Atlantic cod, American plaice, herring, Atlantic salmon (*Salmo salar*) and redfish (Dawe and Beck 1997). It is a significant item in the diet of toothed whales (e.g., bottlenose (*Hyperodon ampullatus*), narwhal, sperm and mink whales (*Balaenoptera acutorostrata*) (Kristensen 1984)). Gaston and Noble (1984) reported *Gonatus* in the diet of thick-billed murres in western Hudson Strait and northeastern Hudson Bay. Northern fulmars also preyed mainly on *Gonatus* (Lydersen et al. 1989). *Gonatus* has also been found as part of the diet of harp and hooded seals in the northwestern Atlantic (Northridge 1984; Ross 1993).

10) Capelin (Mallotus villosus)

Capelin show a circumpolar distribution: in northwestern Atlantic they occur from Hudson Bay to Nova Scotia, with the highest abundance around Newfoundland and Labrador (Fig.6B; Jangaard 1974; Scott and Scott 1988). In 1993, results from acoustic surveys for offshore abundance of capelin in Newfoundland waters (NAFO divisions 2J3K) showed a decline in the size of the offshore stock. In NAFO division 3L the population estimates were very low, especially in 1991 and 1992. This was probably related to particularly low water temperature in Newfoundland waters (Anonymous 1994; Carscadden 1994).

However, in 1993, capelin were found in the bycatch of a shrimp fishery on Flemish Cap, an area where the species was not found before. Moreover, capelin have also increased on the Scotian shelf since the late 1980s, while in Newfoundland stocks from nearshore areas have decreased considerably (Frank and Simon 1994).

Although capelin are not a commonly found in Nova Scotia, their abundance has changed, with distribution ranging in depths of 40 to 150 m in the Scotian Shelf (Anonymous 1996a). Spawning occurs on beaches of Newfoundland and Labrador from June to July and also offshore (on the Grand Banks) at depths of 30 to 125 m (Anonymous 1996a). Capelin are planktivores, feeding mainly on euphausiids, copepods, amphipods and a variety of planktonic specimens (Jangaard 1974) .

Capelin are probably the most important trophic link between zooplankton and different species of fish, marine mammals and seabirds in northern Atlantic waters (Lilly 1991). In the past, capelin was the main prey in the diet of Atlantic cod, while juvenile capelin were prey for Atlantic herring. In Holyrood Bay, Newfoundland, adult capelin is the main item in the diet of short-finned squid during the summer (Dawe and Beck 1997). The occurrence of different species of cetaceans in

Newfoundland waters is associated with the annual increased local abundance of capelin (Piatt et al. 1989) . Capelin are the main prey species for harp seals in offshore areas of Newfoundland (Lawson and Stenson 1995), and are important in nearshore areas as well (Lawson et al. 1995). Seabirds in the central and northern parts of the Gulf of St. Lawrence have capelin as the most important prey in their diet (Cairns et al. 1991). Moreover, capelin is the principal prey for the diet of many seabirds species in the northwestern Atlantic (Birkhead and Nettleship 1987; Smedbol and Wroblewski 1997).

11) Atlantic herring (*Clupea harengus*)

Atlantic herring is a widely-distributed, pelagic species in the northwestern Atlantic. It occurs in inshore and offshore areas from Labrador to Cape Hatteras, United States (Figure 6C; Anonymous 1995b; 1996c). The commercial stocks of herring in Newfoundland waters were abundant until the 1970s, when they started to decline (Pinhorn 1976) likely a result of overfishing.

The spawning time for Atlantic herring differs among population and localities (Scott and Scott 1988). Tagging studies indicates that herring populations from eastern and southeast Newfoundland are spring spawners (Anonymous 1994), whereas herring in the southern Gulf of St. Lawrence are spring and fall spawners. Spring spawning in the Gulf of St. Lawrence occurs at depths of less than 10 m, and fall spawning take place in depths of 5 to 20 m (Tyler 1971b).

Huse and Toresen (1996) reported selective feeding for herring: older fish fed on bigger species of copepod in deeper waters, while juveniles ate smaller copepods in superficial waters. This type of behaviour may facilitate predation by baleen whales, seals and seabirds, which feed on small juvenile herring (10 to 25 cm).

Atlantic herring is an important pelagic prey item for other species of fish, marine mammals and seabirds. Northern gannets and Atlantic puffins exploit juvenile Atlantic herring as a significant prey for their chicks (Montevecchi and Myers, 1996; Rodway and Montevecchi, 1996). Herring are also present in the nearshore diet of pinnipeds in the northwestern Atlantic: herring are consumed by grey seals on the Scotian Shelf (Bowen et al. 1993), hooded seals (with most of Atlantic herring consumed during summer; Ross 1993) and harp seals off the west coast of Newfoundland (Lawson et al. 1995).

12) Daubed shanny (*Lumpenus maculatus*)

The daubed shanny is a widely distributed benthic fish species in the northwestern Atlantic, occurring from the Arctic to the Gulf of Maine (Figure 6D; Scott and Scott 1988). The species is of no commercial interest, and for this reason, little is known about its biology and behaviour. According to Scott and Scott (1988), these fish spawn in shallow waters during winter. However, samples collected on Gannet Island, nearshore coast of Labrador, contained gravid females in August.

Tyler (1971a), studying first communities in Passamaquoddy Bay, found daubed shannys distributed irregularly in this area. This maybe a function of the shanny's benthic life style, as this species could be present in any area, yet be inaccessible to research trawls. Cruise Reports from DFO vessels from 1995 and 1996 (J. Brattey, Department of Fisheries and Oceans, St. John's, Newfoundland, personal communication) indicated that daubed shanny are found in considerable numbers in bycatches of NAFO divisions 2 and 3. They were found throughout the year in depths ranging from 10 to 600 m.

Daubed shanny are important prey for seabirds. For instance, Birkhead and Nettleship (1987) found that the diet of thick-billed murre chicks in Gannet Island, Labrador consisted mainly of daubed shanny in 1982 and 1983. However, new studies revealed that daubed shannys have been the main prey of common and thick-billed murre chicks since the early 1990s in Gannet Island as well (in 1997 they estimated that 75 percent of these birds' diets contained shannys; R. Bryant, unpublished data). Lawson et al. (1995) also reported daubed shanny in harp seal diets, but not commonly.

Appendix B: Proximate Composition of Prey

Prey Species	Weight (g) (g)	Length (mm) (mm)	Sex	Where Caught	Area Caught	Year Caught	Month	Percent Moisture	Percent Protein	Percent Lipid	Percent Ash	Wet ED (kJ•g-1)
American Plaice	15.9	144.0	Male	S Nfld	Nearshore	1996	Jan	79.17	15.64	1.87	3.32	3.84
	24.0	120.0	Male	S Nfld	Nearshore	1996	Jan	77.83	17.41	1.34	3.42	3.99
	43.5	171.0	Male	S Nfld	Nearshore	1996	Jan	74.01	19.67	2.03	4.29	4.71
	56.9	175.0	Male	S Nfld	Nearshore	1996	Jan	77.34	17.05	2.58	3.03	4.39
	63.0	184.0	Female	S Nfld	Nearshore	1996	Jan	80.7	15.47	0.71	3.12	3.36
	65.4	191.0	Male	S Nfld	Nearshore	1996	Jan	77.66	17.04	2.55	2.75	4.38
	67.8	190.0	Male	S Nfld	Nearshore	1996	Jan	76.58	17.1	3.26	3.06	4.66
	68.5	191.0	Male	S Nfld	Nearshore	1996	Jan	79.3	16.12	1.41	3.17	3.76
	71.5	198.0	Male	S Nfld	Nearshore	1996	Jan	70.63	21.0	4.17	4.21	5.78
	79.8	211.0	Female	S Nfld	Nearshore	1996	Jan	78.02	17.67	2.71	1.6	4.56
	81.9	219.0	Female	E Nfld	Offshore	1996	June	79.48	14.64	2.88	3.0	4.02
	86.4	215.0	Female	E Nfld	Offshore	1996	June	78.68	14.8	3.38	3.14	4.25
	90.2	215.0	Female	S Nfld	Nearshore	1996	Jan	79.82	15.8	1.14	3.24	3.59
	91.1	214.0	Male	S Nfld	Nearshore	1996	Jan	83.1	12.47	2.21	2.22	3.33
	91.8	213.0	Female	S Nfld	Nearshore	1996	Jan	77.45	16.58	3.06	2.91	4.48
	91.9	220.0	Female	E Nfld	Offshore	1996	June	79.41	15.36	2.07	3.16	3.86
	94.9	228.0	Female	E Nfld	Offshore	1996	June	79.29	13.6	4.29	2.81	4.35
	117.4	235.0	Male	E Nfld	Offshore	1996	June	80.3	16.0	1.65	2.05	3.83
	118.8	240.0	Male	E Nfld	Offshore	1996	June	78.46	14.78	3.82	2.94	4.41
	131.2	230.0	Male	E Nfld	Offshore	1996	June	78.76	14.06	3.47	3.71	4.13
	140.8	250.0	Female	E Nfld	Offshore	1996	June	79.41	16.39	1.95	2.25	4.02
	150.9	290.0	Female	E Nfld	Offshore	1996	June	78.93	15.39	3.02	2.66	4.23
	152.0	239.0	Male	E Nfld	Offshore	1996	June	78.05	15.03	3.29	3.62	4.26
	153.5	249.0	Female	E Nfld	Offshore	1996	June	80.01	15.24	2.19	2.55	3.88
	154.4	279.0	Male	E Nfld	Offshore	1996	June	78.91	15.26	2.83	3.01	4.12
	183.1	274.0	Female	E Nfld	Offshore	1996	June	76.63	16.81	3.14	3.42	4.56
	198.3	280.0	Female	E Nfld	Offshore	1996	June	77.86	15.27	3.74	3.13	4.47
	200.8	270.0	Female	E Nfld	Offshore	1996	June	78.51	14.75	3.32	3.43	4.21
	211.8	285.0	Female	E Nfld	Offshore	1996	June	78.27	14.56	3.67	3.51	4.3
	214.2	281.0	Female	E Nfld	Offshore	1996	June	77.74	14.92	4.13	3.21	4.55
	228.9	300.0	Female	E Nfld	Offshore	1996	June	78.6	14.68	3.17	3.55	4.14
	341.2	327.0	Female	E Nfld	Offshore	1996	June	76.77	14.03	5.27	3.94	4.81
	344.9	339.0	Female	E Nfld	Offshore	1996	June	77.41	14.96	4.01	3.62	4.52
	345.1	315.0	Female	E Nfld	Offshore	1996	June	77.96	15.68	3.81	2.55	4.59
	346.6	321.0	Female	E Nfld	Offshore	1996	June	76.68	14.14	5.77	3.41	5.02
	372.0	342.0	Female	E Nfld	Offshore	1996	June	78.62	14.64	3.65	3.09	4.31
	373.6	325.0	Female	E Nfld	Offshore	1996	June	77.28	14.24	4.79	3.69	4.67
Arctic Cod	13.0	98.0	Unk	Labrador	Offshore	1991	Nov	79.65	12.89	5.76	1.54	4.32
	14.0	108.0	Unk	Labrador	Offshore	1991	Nov	79.38	12.04	5.82	1.44	4.2
	15.1	114.0	Unk	Labrador	Offshore	1991	Nov	80.77	11.61	5.58	1.2	4.04
	15.2	115.0	Female	E Nfld	Offshore	1995	Nov	77.27	16.82	3.75	2.16	4.79
	15.8	124.0	Female	Labrador	Nearshore	1996	May	77.5	16.86	3.15	2.49	4.57
	17.0	119.0	Unk	Labrador	Offshore	1991	Nov	81.14	15.48	3.43	1.72	3.88
	17.3	120.0	Female	E Nfld	Offshore	1995	Nov	78.46	15.04	4.32	2.18	4.65
	18.3	122.0	Female	E Nfld	Offshore	1995	Nov	75.55	16.68	5.41	2.36	5.39
	19.6	120.0	Female	E Nfld	Offshore	1995	Nov	78.0	15.79	4.08	2.13	4.71

Appendix B: Proximate Composition of Prey (cont.)

Arctic	20.8	134.0	Female	Labrador	Nearshore	1996	May	80.98	10.46	5.79	2.77	4.29
Cod	21.0	126.0	Unk	Labrador	Offshore	1991	Nov	80.0	12.89	5.52	1.59	4.23
	21.3	141.0	Female	Labrador	Nearshore	1996	May	79.77	15.07	2.74	2.42	4.06
	21.7	128.0	Female	E Nfld	Offshore	1995	Nov	79.64	15.82	2.32	2.22	4.04
	21.7	132.0	Female	NE Nfld	Offshore	1994	Dec	73.71	16.68	7.5	2.1	6.19
	22.7	133.0	Female	E Nfld	Offshore	1995	Nov	78.45	16.12	3.27	2.15	4.47
	22.9	154.0	Female	NE Nfld	Offshore	1994	Dec	78.5	16.28	2.58	2.65	4.23
	23.0	129.0	Male	E Nfld	Offshore	1995	Nov	79.34	14.89	3.67	2.1	4.37
	23.0	134.0	Female	E Nfld	Offshore	1995	Nov	78.38	16.2	3.3	2.11	4.5
	23.8	136.0	Female	E Nfld	Offshore	1995	Nov	76.96	16.68	4.25	2.11	4.95
	23.9	138.0	Female	E Nfld	Offshore	1995	Nov	76.19	16.14	5.56	2.11	5.34
	24.2	131.0	Male	E Nfld	Offshore	1995	Nov	76.72	14.64	6.41	2.23	5.36
	24.2	132.0	Male	E Nfld	Offshore	1995	Nov	79.4	14.98	3.4	2.22	4.29
	24.4	130.0	Male	NE Nfld	Offshore	1994	Dec	78.5	14.53	4.98	1.99	4.8
	24.8	146.0	Female	Labrador	Nearshore	1996	May	77.5	16.58	3.42	2.5	4.62
	25.1	142.0	Female	E Nfld	Offshore	1995	Nov	75.74	15.93	6.09	2.24	5.5
	25.5	136.0	Male	NE Nfld	Offshore	1994	Dec	77.88	14.71	5.23	2.18	4.93
	25.7	136.0	Female	E Nfld	Offshore	1995	Nov	77.89	16.9	2.81	2.39	4.45
	25.9	130.0	Male	Labrador	Nearshore	1996	May	78.57	14.86	3.97	2.6	4.48
	26.9	148.0	Male	NE Nfld	Offshore	1994	Dec	78.95	14.14	4.68	2.24	4.6
	27.2	145.0	Male	E Nfld	Offshore	1995	Nov	76.33	15.02	6.48	2.17	5.47
	28.2	154.0	Male	E Nfld	Nearshore	1996	Feb	83.17	11.17	2.96	2.7	3.36
	28.2	155.0	Male	Labrador	Nearshore	1996	May	79.24	14.73	3.35	2.68	4.22
	28.7	141.0	Female	E Nfld	Offshore	1995	Nov	76.69	16.84	4.28	2.2	4.99
	28.7	161.0	Male	E Nfld	Nearshore	1996	Feb	83.09	12.06	1.85	3.0	3.11
	28.8	175.0	Male	E Nfld	Nearshore	1996	Feb	83.81	14.31	0.83	1.05	3.18
	28.9	156.0	Male	Labrador	Nearshore	1996	May	77.46	14.33	5.56	2.65	4.98
	30.5	151.0	Male	E Nfld	Offshore	1995	Nov	78.08	15.61	4.07	2.24	4.67
	31.2	146.0	Female	E Nfld	Offshore	1995	Nov	75.38	16.16	6.47	1.98	5.69
	31.6	172.0	Male	E Nfld	Nearshore	1996	Feb	84.75	11.78	0.64	2.83	2.6
	32.1	141.0	Male	E Nfld	Offshore	1995	Nov	78.24	15.18	4.49	2.09	4.74
	32.6	134.0	Female	Labrador	Nearshore	1996	May	78.18	15.79	3.44	2.59	4.47
	32.7	159.0	Male	E Nfld	Nearshore	1996	Feb	80.97	13.56	3.24	2.23	3.94
	32.7	164.0	Male	E Nfld	Nearshore	1996	Feb	81.68	13.31	2.47	2.54	3.6
	34.0	158.0	Male	NE Nfld	Offshore	1994	Dec	78.5	16.84	2.25	2.4	4.23
	35.1	139.0	Female	E Nfld	Offshore	1995	Nov	77.39	16.11	4.33	2.16	4.87
	35.1	156.0	Female	NE Nfld	Offshore	1994	Dec	76.62	15.99	4.99	2.4	5.09
	35.7	171.0	Male	E Nfld	Nearshore	1996	Feb	82.67	12.67	2.05	2.61	3.31
	37.5	174.0	Female	E Nfld	Nearshore	1996	Feb	83.39	12.34	1.75	2.52	3.13
	43.5	167.0	Female	E Nfld	Offshore	1995	Nov	74.52	17.33	5.92	2.24	5.71
	45.0	179.0	Male	NE Nfld	Offshore	1994	Dec	78.02	15.26	4.56	2.16	4.78
	45.6	194.0	Female	NE Nfld	Offshore	1994	Dec	76.09	17.45	4.22	2.24	5.09
	46.0	174.0	Female	Labrador	Nearshore	1996	May	79.52	14.41	3.52	2.55	4.22
	46.2	198.0	Female	E Nfld	Nearshore	1996	Feb	82.98	12.14	2.27	2.61	3.29
	46.6	203.0	Female	E Nfld	Nearshore	1996	Feb	81.68	13.84	1.31	3.17	3.27
	47.2	209.0	Female	E Nfld	Nearshore	1996	Feb	82.99	13.25	0.97	2.79	3.02
	47.4	204.0	Female	E Nfld	Nearshore	1996	Feb	81.95	13.21	2.34	2.5	3.53
	47.7	204.0	Female	E Nfld	Nearshore	1996	Feb	83.63	12.17	0.97	3.23	2.8
	47.9	159.0	Male	E Nfld	Offshore	1995	Nov	76.81	15.32	5.99	1.88	5.34
	48.4	177.0	Female	E Nfld	Offshore	1995	Nov	77.51	16.5	3.79	2.21	4.74

Appendix B: Proximate Composition of Prey (cont.)

Arctic	51.9	177.0	Female	E Nfld	Offshore	1995	Nov	78.44	15.77	3.69	2.1	4.56
cod	52.3	189.0	Female	NE Nfld	Offshore	1994	Dec	78.5	14.56	4.95	2.0	4.79
	52.4	177.0	Female	E Nfld	Offshore	1995	Nov	76.76	17.82	3.08	2.34	4.74
	53.3	180.0	Female	E Nfld	Offshore	1995	Nov	77.66	15.64	4.49	2.21	4.84
	53.4	186.0	Female	NE Nfld	Offshore	1994	Dec	77.19	17.67	3.08	2.05	4.71
	54.4	207.0	Female	E Nfld	Nearshore	1996	Feb	83.51	12.4	1.12	2.97	2.9
	55.9	185.0	Male	E Nfld	Offshore	1995	Nov	77.92	16.86	3.12	2.09	4.56
	56.3	183.0	Male	E Nfld	Offshore	1995	Nov	77.52	17.27	2.96	2.25	4.58
	61.5	170.0	Male	E Nfld	Offshore	1995	Nov	79.15	15.09	3.52	2.24	4.36
	63.4	207.0	Female	NE Nfld	Offshore	1994	Dec	78.42	15.96	3.15	2.47	4.39
	72.0	199.0	Male	NE Nfld	Offshore	1994	Dec	78.77	15.61	3.34	2.28	4.39
	86.9	219.0	Female	NE Nfld	Offshore	1994	Dec	76.29	16.64	4.72	2.35	5.12
	106.0	232.0	Female	NE Nfld	Offshore	1994	Dec	76.32	20.48	0.95	2.25	4.46
	136.7	293.0	Female	NE Nfld	Offshore	1994	Dec	81.09	14.71	1.34	2.86	3.45
Atlantic	16.0	96.0	Unk	Labrador	Nearshore	1995	July	79.67	16.23	1.05	3.05	3.64
Cod	16.5	126.0	Unk	Labrador	Nearshore	1995	July	77.88	15.62	2.35	4.15	4.02
	16.8	114.0	Unk	Labrador	Nearshore	1995	July	78.63	15.7	3.42	2.25	4.44
	17.8	98.0	Unk	Labrador	Nearshore	1995	July	78.17	16.31	2.61	2.91	4.25
	18.0	112.0	Unk	Labrador	Nearshore	1995	July	78.87	15.24	3.63	2.26	4.43
	18.2	117.0	Unk	Labrador	Nearshore	1995	July	78.32	16.03	3.3	2.34	4.46
	19.1	121.0	Unk	Labrador	Nearshore	1995	July	78.72	16.64	1.55	3.09	3.92
	19.9	119.0	Female	Labrador	Nearshore	1995	July	77.99	15.41	3.58	3.03	4.44
	19.9	125.0	Unk	Labrador	Nearshore	1995	July	80.25	14.87	2.66	2.23	3.98
	20.7	125.0	Unk	Labrador	Nearshore	1995	July	78.36	16.01	2.82	2.81	4.27
	20.7	128.0	Unk	Labrador	Nearshore	1995	July	77.71	16.64	2.55	3.1	4.3
	21.1	125.0	Unk	Labrador	Nearshore	1995	July	78.49	14.99	4.18	2.34	4.59
	21.3	120.0	Female	Labrador	Nearshore	1995	July	76.16	16.92	3.6	3.31	4.75
	23.0	112.0	Male	Labrador	Nearshore	1995	July	75.71	17.6	3.67	3.02	4.91
	24.1	131.0	Unk	Labrador	Nearshore	1995	July	78.39	15.96	2.69	2.97	4.21
	25.7	126.0	Unk	Labrador	Nearshore	1995	July	78.87	14.77	4.13	2.23	4.52
	25.7	128.0	Unk	Labrador	Nearshore	1995	July	80.57	13.71	2.56	3.16	3.72
	26.5	144.0	Unk	Labrador	Nearshore	1995	July	77.58	16.17	3.56	2.69	4.59
	26.9	122.0	Male	Labrador	Nearshore	1995	July	75.14	18.01	3.48	3.37	4.92
	27.0	143.0	Unk	Labrador	Nearshore	1995	July	79.2	14.52	2.68	3.6	3.92
	27.3	130.0	Unk	Labrador	Nearshore	1995	July	80.6	14.82	2.31	2.27	3.84
	29.0	142.0	Unk	Labrador	Nearshore	1995	July	78.11	16.76	2.12	3.01	4.16
	30.6	143.0	Unk	Labrador	Nearshore	1995	July	80.0	14.82	2.78	2.4	4.02
	31.0	154.0	Male	Labrador	Nearshore	1995	July	80.37	15.06	1.72	2.85	3.67
	33.4	152.0	Unk	Labrador	Nearshore	1995	July	78.86	15.69	2.73	2.72	4.18
	34.5	158.0	Unk	Labrador	Nearshore	1995	July	79.8	16.02	1.85	2.33	3.91
	35.0	151.0	Male	Labrador	Nearshore	1995	July	76.85	15.94	4.27	2.95	4.81
	37.0	167.0	Male	E Nfld	Nearshore	1995	Aug	79.4	16.44	0.89	3.27	3.63
	37.9	154.0	Female	Labrador	Nearshore	1995	July	78.9	14.76	3.18	3.16	4.16
	43.0	166.0	Male	Labrador	Nearshore	1995	July	76.85	17.82	1.81	3.52	4.25
	43.2	167.0	Unk	Labrador	Nearshore	1995	July	78.15	16.07	2.84	2.93	4.29
	48.8	173.0	Female	Labrador	Nearshore	1995	July	80.99	14.63	1.4	2.99	3.46
	49.4	179.0	Male	E Nfld	Nearshore	1995	Aug	78.84	15.8	2.38	2.97	4.07
	49.6	184.0	Unk	Labrador	Nearshore	1995	July	78.38	16.53	2.18	2.51	4.13
	50.7	178.0	Unk	Labrador	Nearshore	1995	July	78.8	15.97	2.85	2.38	4.28

Appendix B: Proximate Composition of Prey (cont.)

Atlantic	54.2	182.0	Unk	Labrador	Nearshore	1995	July	77.45	17.74	2.52	2.3	4.5
Cod	54.6	173.0	Female	Labrador	Nearshore	1995	July	79.56	15.43	2.44	2.57	4.01
	55.5	182.0	Unk	Labrador	Nearshore	1995	July	81.35	14.81	0.72	3.12	3.23
	55.9	164.0	Male	Labrador	Nearshore	1995	July	78.04	16.19	2.29	3.48	4.11
	57.1	187.0	Male	E Nfld	Nearshore	1995	Aug	78.76	15.31	3.13	2.79	4.25
	57.9	192.0	Unk	Labrador	Nearshore	1995	July	79.7	15.38	2.17	2.75	3.9
	58.4	189.0	Female	E Nfld	Nearshore	1995	Aug	65.98	26.92	1.77	5.32	6.06
	58.7	183.0	Male	E Nfld	Nearshore	1995	Aug	80.04	15.69	1.52	2.75	3.71
	59.7	168.0	Male	Labrador	Nearshore	1995	July	81.01	14.05	2.17	2.77	3.63
	60.0	185.0	Unk	Labrador	Nearshore	1995	July	80.79	15.14	1.77	2.31	3.7
	60.7	191.0	Male	E Nfld	Nearshore	1995	Aug	80.07	15.45	1.49	2.99	3.66
	61.5	189.0	Male	Labrador	Nearshore	1995	July	79.63	15.25	2.44	2.68	3.96
	63.7	190.0	Male	Labrador	Nearshore	1995	July	79.36	15.41	2.51	2.72	4.04
	64.5	193.0	Female	Labrador	Nearshore	1995	July	80.5	15.3	1.76	2.44	3.73
	64.6	168.0	Male	Labrador	Nearshore	1995	July	77.15	16.57	3.34	2.94	4.58
	65.5	190.0	Unk	Labrador	Nearshore	1995	July	80.23	14.88	1.67	3.22	3.61
	66.6	195.0	Female	Labrador	Nearshore	1995	July	78.77	15.18	3.42	2.63	4.34
	66.8	170.0	Female	Labrador	Nearshore	1995	July	77.84	16.13	3.17	2.86	4.43
	68.7	179.0	Male	Labrador	Nearshore	1995	July	76.54	17.6	2.99	2.87	4.66
	69.4	200.0	Male	E Nfld	Nearshore	1995	Aug	78.97	16.69	1.38	2.96	3.86
	70.2	195.0	Male	Labrador	Nearshore	1995	July	79.64	14.85	2.74	2.77	4.01
	71.7	198.0	Female	E Nfld	Nearshore	1995	Aug	79.76	15.81	1.5	2.93	3.73
	73.0	176.0	Male	Labrador	Nearshore	1995	July	77.22	16.25	3.56	2.96	4.6
	73.0	199.0	Female	Labrador	Nearshore	1995	July	79.17	16.39	1.34	3.1	3.79
	73.2	197.0	Female	Labrador	Nearshore	1995	July	80.72	14.43	1.86	2.99	3.59
	74.1	196.0	Female	Labrador	Nearshore	1995	July	79.03	16.44	1.47	3.06	3.85
	74.2	180.0	Male	Labrador	Nearshore	1995	July	78.27	16.93	1.92	2.87	4.12
	76.0	198.0	Male	Labrador	Nearshore	1995	July	78.47	15.34	3.48	2.7	4.39
	76.8	191.0	Unk	Labrador	Nearshore	1995	July	79.94	15.55	1.75	2.76	3.77
	76.8	201.0	Unk	Labrador	Nearshore	1995	July	78.68	15.53	2.76	3.03	4.16
	80.4	203.0	Female	E Nfld	Nearshore	1995	Aug	80.51	14.45	1.92	3.12	3.62
	80.8	213.0	Unk	Labrador	Nearshore	1995	July	79.19	15.29	2.74	2.78	4.1
	81.8	194.0	Unk	Labrador	Nearshore	1995	July	71.1	21.24	4.07	3.59	5.79
	84.9	208.0	Female	Labrador	Nearshore	1995	July	78.88	15.41	2.79	2.92	4.14
	85.1	217.0	Female	Labrador	Nearshore	1995	July	79.45	16.25	1.55	2.75	3.84
	85.8	199.0	Female	E Nfld	Nearshore	1995	Aug	87.24	9.33	2.21	1.22	2.71
	86.9	208.0	Male	Labrador	Nearshore	1995	July	77.73	16.63	2.27	3.36	4.19
	87.5	216.0	Male	E Nfld	Nearshore	1995	Aug	79.9	15.8	1.4	2.9	3.69
	88.2	198.0	Unk	Labrador	Nearshore	1995	July	81.53	13.9	2.09	2.49	3.57
	91.6	202.0	Female	Labrador	Nearshore	1995	July	76.14	17.71	3.33	2.82	4.81
	92.4	189.0	Female	Labrador	Nearshore	1995	July	77.85	15.7	3.92	2.53	4.63
	94.9	208.0	Unk	Labrador	Nearshore	1995	July	78.76	16.19	2.25	2.8	4.09
	96.4	222.0	Female	Labrador	Nearshore	1995	July	78.19	16.09	2.96	2.76	4.34
	98.1	210.0	Male	Labrador	Nearshore	1995	July	77.12	17.29	2.71	2.87	4.49
	98.4	200.0	Male	Labrador	Nearshore	1995	July	78.89	15.66	2.5	2.95	4.08
	106.3	217.0	Female	Labrador	Nearshore	1995	July	79.56	15.79	1.33	3.32	3.66
	113.6	229.0	Female	Labrador	Nearshore	1995	July	79.39	16.15	1.71	2.75	3.88
	114.1	212.0	Female	E Nfld	Nearshore	1995	Aug	79.12	15.69	2.41	2.78	4.05
	155.5	232.0	Female	Labrador	Nearshore	1995	July	78.18	16.6	2.39	2.83	4.23
	179.2	245.0	Male	Labrador	Nearshore	1995	July	77.54	18.33	0.46	3.67	3.84

Appendix B: Proximate Composition of Prey (cont.)

Atlantic Cod	251.0	263.0	Female	Labrador	Nearshore	1995	July	77.2	16.06	3.75	2.99	4.64
	313.0	279.0	Male	Labrador	Nearshore	1995	July	78.52	15.52	2.72	3.24	4.14
	317.2	328.0	Male	Labrador	Nearshore	1995	July	77.73	17.29	2.25	2.74	4.31
	437.5	315.0	Female	Labrador	Nearshore	1995	July	80.63	14.92	1.75	2.7	3.65
	439.7	310.0	Male	Labrador	Nearshore	1995	July	79.77	15.89	1.65	2.68	3.81
	450.0	359.0	Female	E Nfld	Nearshore	1995	Aug	76.07	16.46	5.13	2.34	5.24
	514.0	385.0	Female	E Nfld	Nearshore	1995	Aug	79.11	16.93	1.34	2.62	3.89
	530.6	377.0	Female	E Nfld	Nearshore	1995	Aug	74.94	17.08	4.65	3.33	5.18
	585.1	389.0	Male	E Nfld	Nearshore	1995	Aug	75.8	17.83	4.39	1.98	5.23
	607.3	365.0	Female	E Nfld	Nearshore	1995	July	75.77	15.82	4.98	3.43	5.06
	671.0	425.0	Male	E Nfld	Nearshore	1995	Aug	77.61	19.97	9.25	2.42	7.51
	691.2	416.0	Female	E Nfld	Nearshore	1995	Aug	75.94	16.47	4.27	3.32	4.92
	703.8	386.0	Male	E Nfld	Nearshore	1995	Aug	76.67	15.35	4.86	3.12	4.92
	773.3	432.0	Male	E Nfld	Nearshore	1995	Aug	79.11	15.18	1.87	3.84	3.75
	868.1	473.0	Female	E Nfld	Nearshore	1995	Aug	78.17	15.28	3.45	3.1	4.37
Atlantic Herring	153.0	252.0	Unk	E Nfld	Nearshore	1992	Nov	61.4	19.48	18.16	0.96	10.8
	170.0	260.0	Unk	E Nfld	Nearshore	1995	Mar	73.95	18.83	4.75	2.48	5.57
	200.0	276.0	Unk	E Nfld	Nearshore	1992	Nov	65.9	20.79	12.62	0.68	8.96
	204.0	267.0	Unk	E Nfld	Nearshore	1994	Sept	70.28	16.41	11.8	1.51	7.77
	209.0	264.0	Unk	E Nfld	Nearshore	1992	Nov	66.4	21.39	11.38	0.83	8.6
	216.0	270.0	Unk	E Nfld	Nearshore	1992	Nov	66.6	21.43	11.1	0.87	8.51
	217.0	269.0	Unk	E Nfld	Nearshore	1994	Sept	66.59	18.26	13.04	2.1	8.61
	220.0	258.0	Unk	E Nfld	Nearshore	1993	Oct	61.6	19.46	18.02	0.92	10.74
	228.3	299.0	Female	E Nfld	Nearshore	1996	Oct	73.2	18.39	5.94	2.47	5.94
	233.0	274.0	Unk	E Nfld	Nearshore	1993	Oct	62.0	19.27	17.83	0.9	10.63
	242.0	254.0	Unk	E Nfld	Nearshore	1992	Nov	65.1	24.73	9.28	0.89	8.47
	242.0	278.0	Unk	E Nfld	Nearshore	1992	Nov	64.0	20.79	14.32	0.89	9.6
	248.0	264.0	Unk	E Nfld	Nearshore	1993	Oct	63.9	19.62	15.56	0.92	9.84
	248.0	282.0	Unk	E Nfld	Nearshore	1992	Nov	66.9	20.14	12.07	0.89	8.62
	252.0	256.0	Unk	E Nfld	Nearshore	1993	Oct	61.2	18.84	19.0	0.96	10.99
	253.0	292.0	Unk	E Nfld	Nearshore	1992	Nov	65.2	19.76	14.27	0.77	9.38
	254.0	278.0	Unk	E Nfld	Nearshore	1992	Nov	67.1	20.02	12.06	0.81	8.59
	259.0	270.0	Unk	E Nfld	Nearshore	1993	Oct	62.1	18.97	17.95	0.97	10.62
	262.0	292.0	Unk	E Nfld	Nearshore	1992	Nov	65.3	21.31	12.6	0.79	9.05
	263.0	301.0	Unk	E Nfld	Nearshore	1994	Feb	73.5	20.5	5.24	0.76	6.09
	264.0	268.0	Unk	E Nfld	Nearshore	1993	Oct	67.3	20.07	11.75	0.88	8.48
	268.0	300.0	Unk	E Nfld	Nearshore	1993	Oct	62.6	19.56	16.9	0.93	10.34
	272.9	300.0	Female	E Nfld	Nearshore	1996	Oct	73.22	17.78	6.4	2.6	5.99
	280.0	276.0	Unk	E Nfld	Nearshore	1993	Oct	62.0	18.73	18.38	0.89	10.73
	280.0	282.0	Unk	E Nfld	Nearshore	1993	Oct	63.2	18.85	17.13	0.82	10.28
	283.0	290.0	Unk	E Nfld	Nearshore	1993	Oct	63.5	20.76	14.88	0.86	9.81
	283.2	302.0	Female	E Nfld	Nearshore	1995	Oct	70.47	17.49	9.81	2.23	7.23
	289.0	310.0	Unk	E Nfld	Nearshore	1994	Feb	75.9	21.43	1.96	0.71	5.03
	293.0	296.0	Unk	E Nfld	Nearshore	1994	Sept	69.18	16.53	12.16	2.12	7.93
	294.6	300.0	Female	E Nfld	Nearshore	1995	Oct	66.85	19.77	11.29	2.08	8.24
	296.0	290.0	Unk	E Nfld	Nearshore	1995	Mar	70.35	17.3	10.13	2.22	7.31
	296.2	308.0	Female	E Nfld	Nearshore	1995	Oct	64.99	18.96	14.21	1.84	9.19
	311.0	274.0	Unk	E Nfld	Nearshore	1993	Oct	64.0	19.06	16.14	0.8	9.94
	314.0	280.0	Unk	E Nfld	Nearshore	1993	Oct	63.6	19.41	16.15	0.84	10.02

Appendix B: Proximate Composition of Prey (cont.)

Atlantic	394.0	300.0	Unk	E Nfld	Nearshore	1993	Oct	65.5	19.05	14.64	0.81	9.37
Herring	395.0	300.0	Unk	E Nfld	Nearshore	1995	Mar	70.21	19.83	7.55	2.41	6.84
	416.0	325.0	Unk	E Nfld	Nearshore	1995	Mar	68.71	16.8	11.82	2.67	7.85
Capelin	11.2	114.0	Female	E Nfld	Offshore	1995	Oct	76.64	7.79	14.4	1.17	7.03
	11.6	119.0	Male	E Nfld	Offshore	1995	Oct	64.0	14.22	19.78	2.0	10.36
	12.1	124.0	Female	E Nfld	Offshore	1995	Oct	59.26	11.81	26.94	1.99	12.6
	12.6	121.0	Female	E Nfld	Offshore	1995	Oct	63.1	12.32	22.64	1.95	11.07
	12.6	126.0	Male	E Nfld	Offshore	1995	Oct	66.67	17.8	13.26	2.27	8.6
	13.0	124.0	Female	E Nfld	Offshore	1995	Oct	63.44	18.95	15.29	2.32	9.6
	13.2	127.0	Male	E Nfld	Offshore	1995	Oct	64.58	16.62	16.48	2.32	9.59
	13.6	125.0	Female	E Nfld	Offshore	1995	Oct	64.07	15.48	18.5	1.95	10.13
	13.8	125.0	Female	E Nfld	Offshore	1995	Oct	62.63	16.48	18.88	2.01	10.47
	14.2	124.0	Female	E Nfld	Offshore	1995	Oct	62.26	16.16	19.53	2.05	10.65
	14.2	125.0	Female	E Nfld	Offshore	1995	Oct	66.35	15.86	15.89	1.9	9.21
	14.3	122.0	Female	E Nfld	Offshore	1995	Oct	65.42	19.03	13.5	2.05	8.94
	14.9	130.0	Male	E Nfld	Offshore	1995	Oct	63.4	16.78	17.42	2.4	9.98
	14.9	149.0	Male	E Nfld	Offshore	1995	Oct	62.5	16.38	18.84	2.28	10.43
	15.9	135.0	Female	E Nfld	Offshore	1996	June	78.86	15.84	3.42	1.88	4.47
	15.9	138.0	Male	E Nfld	Offshore	1995	Oct	66.39	15.91	15.93	1.77	9.24
	16.4	130.0	Female	E Nfld	Offshore	1995	Oct	64.57	15.73	17.72	1.98	9.88
	16.7	130.0	Female	E Nfld	Offshore	1995	Oct	59.84	17.63	20.71	1.82	11.4
	16.7	136.0	Female	E Nfld	Offshore	1995	Oct	59.23	20.81	17.85	2.11	10.95
	16.7	137.0	Female	E Nfld	Offshore	1996	June	80.3	15.51	2.24	1.95	3.95
	16.8	139.0	Unk	E Nfld	Offshore	1995	Oct	62.8	15.91	18.81	2.48	10.33
	16.9	135.0	Female	E Nfld	Offshore	1995	Oct	68.89	14.93	14.06	2.12	8.33
	16.9	135.0	Male	E Nfld	Offshore	1995	Oct	60.16	13.59	24.59	1.67	12.06
	16.9	135.0	Unk	E Nfld	Offshore	1995	Oct	63.78	16.12	17.59	2.52	9.91
	17.0	139.0	Female	E Nfld	Offshore	1995	Oct	66.92	15.0	15.87	2.21	9.03
	17.2	138.0	Female	E Nfld	Offshore	1996	June	81.62	14.54	1.98	1.86	3.66
	17.2	139.0	Male	E Nfld	Offshore	1996	June	80.15	15.57	2.25	2.02	3.97
	17.3	136.0	Female	E Nfld	Offshore	1995	Oct	57.14	24.91	16.21	1.74	11.14
	17.5	138.0	Male	E Nfld	Offshore	1995	Oct	61.76	15.56	20.27	2.4	10.82
	17.6	135.0	Female	E Nfld	Offshore	1995	Oct	54.41	14.24	30.55	0.8	14.46
	17.6	154.0	Male	E Nfld	Offshore	1996	June	82.61	13.67	1.1	2.61	3.15
	17.9	138.0	Male	E Nfld	Offshore	1995	Oct	64.49	15.84	17.21	2.46	9.71
	18.0	135.0	Female	E Nfld	Offshore	1996	June	80.0	14.76	3.49	1.75	4.28
	18.0	135.0	Male	E Nfld	Offshore	1995	Oct	62.23	15.7	20.0	2.07	10.74
	18.2	141.0	Female	E Nfld	Offshore	1996	June	75.68	15.54	7.03	1.75	5.78
	18.4	140.0	Female	E Nfld	Offshore	1996	June	80.14	15.59	2.32	1.95	4.0
	18.4	143.0	Male	E Nfld	Offshore	1995	Oct	64.2	16.62	16.96	2.21	9.77
	18.5	130.0	Female	E Nfld	Offshore	1995	Oct	65.33	15.28	17.49	1.9	9.7
	18.5	144.0	Male	E Nfld	Offshore	1995	Oct	61.64	16.77	18.82	2.77	10.5
	18.7	140.0	Female	E Nfld	Offshore	1995	Oct	61.84	17.23	18.88	2.05	10.62
	18.9	139.0	Male	E Nfld	Offshore	1995	Oct	60.26	19.05	18.45	2.24	10.82
	19.0	138.0	Male	E Nfld	Offshore	1995	Oct	62.34	16.01	19.71	1.94	10.69
	19.0	140.0	Male	E Nfld	Offshore	1995	Oct	59.35	14.96	23.3	2.39	11.85
	19.1	140.0	Male	E Nfld	Offshore	1995	Oct	61.49	16.59	20.17	1.76	10.98
	19.1	140.0	Male	E Nfld	Offshore	1996	June	79.87	14.99	3.04	2.1	4.15
	19.1	143.0	Male	E Nfld	Offshore	1995	Oct	60.76	15.65	21.53	2.06	11.31

Appendix B: Proximate Composition of Prey (cont.)

Capelin	19.5	140.0	Female	E Nfld	Offshore	1996	June	80.5	15.03	2.67	1.79	4.02
	19.5	145.0	Male	E Nfld	Offshore	1996	June	78.26	15.56	4.12	2.05	4.68
	19.6	143.0	Female	E Nfld	Offshore	1996	June	80.25	14.82	2.99	1.94	4.1
	19.6	144.0	Male	E Nfld	Offshore	1996	June	80.0	15.06	2.76	2.18	4.06
	19.7	143.0	Male	E Nfld	Offshore	1995	Oct	60.49	15.61	21.6	2.3	11.33
	19.7	143.0	Male	E Nfld	Offshore	1995	Oct	61.25	16.24	20.27	2.23	10.95
	19.7	143.0	Male	E Nfld	Offshore	1996	June	81.99	14.56	1.58	1.87	3.51
	19.7	147.0	Female	E Nfld	Offshore	1995	Oct	64.9	9.75	23.01	2.34	10.69
	20.9	138.0	Male	E Nfld	Offshore	1995	Oct	61.76	17.1	18.57	2.57	10.48
	21.3	148.0	Male	E Nfld	Offshore	1996	June	79.89	14.7	3.11	2.3	4.12
	21.6	140.0	Male	E Nfld	Offshore	1996	June	80.66	14.83	2.41	2.1	3.88
	21.6	141.0	Male	E Nfld	Offshore	1995	Oct	61.33	14.55	22.33	1.79	11.4
	22.0	145.0	Male	E Nfld	Offshore	1995	Oct	60.96	16.27	20.01	2.76	10.86
	22.0	149.0	Female	E Nfld	Offshore	1996	June	73.77	15.64	8.65	1.94	6.42
	22.4	147.0	Male	E Nfld	Offshore	1995	Oct	60.96	16.78	20.25	2.01	11.05
	22.5	148.0	Male	E Nfld	Offshore	1995	Oct	18.6	56.65	19.84	4.91	18.87
	22.5	148.0	Male	E Nfld	Offshore	1995	Oct	64.13	15.77	18.03	2.07	10.01
	22.5	150.0	Female	E Nfld	Offshore	1996	June	79.37	14.73	3.9	2.01	4.43
	22.6	146.0	Male	E Nfld	Offshore	1995	Oct	61.17	16.21	21.07	1.55	11.25
	22.6	148.0	Male	E Nfld	Offshore	1996	June	79.06	13.83	5.46	1.65	4.84
	22.9	151.0	Male	E Nfld	Offshore	1996	June	78.24	15.36	4.31	2.08	4.71
	22.9	152.0	Female	E Nfld	Offshore	1996	June	76.68	14.87	6.39	2.06	5.4
	23.3	150.0	Male	E Nfld	Offshore	1996	June	80.0	14.5	3.7	1.8	4.31
	24.2	149.0	Male	E Nfld	Offshore	1996	June	78.74	15.0	4.53	1.73	4.72
	24.4	153.0	Male	E Nfld	Offshore	1996	June	77.99	14.61	5.45	1.96	4.99
	25.7	147.0	Female	Labrador	Nearshore	1996	Aug	73.12	20.67	4.21	2.0	5.73
	26.2	140.0	Male	E Nfld	Offshore	1995	Oct	56.88	17.27	24.01	1.84	12.58
	26.6	153.0	Male	E Nfld	Offshore	1995	Oct	60.35	16.42	21.42	1.8	11.43
	26.7	150.0	Female	Labrador	Nearshore	1996	Aug	73.06	19.49	5.52	1.93	6.0
	28.2	157.0	Male	E Nfld	Offshore	1996	June	78.51	14.74	4.73	2.02	4.75
	30.6	166.0	Male	E Nfld	Offshore	1996	June	77.29	14.33	6.46	1.92	5.32
	31.2	159.0	Male	E Nfld	Offshore	1996	June	76.26	15.28	6.49	1.97	5.52
	31.5	160.0	Male	E Nfld	Offshore	1996	June	76.7	14.35	7.0	1.95	5.53
	35.1	168.0	Male	E Nfld	Offshore	1996	June	76.92	13.5	7.49	2.09	5.55
	36.4	172.0	Male	E Nfld	Offshore	1996	June	75.69	15.34	6.96	2.01	5.71
Daubed	8.7	127.0	Unk	Labrador	Nearshore	1996	Aug	70.83	20.23	6.02	2.92	6.33
Shanney	8.8	137.0	Female	Labrador	Nearshore	1996	Aug	72.55	20.81	3.15	3.49	5.36
	9.8	131.0	Unk	Labrador	Nearshore	1996	Aug	70.49	20.61	5.76	3.14	6.31
	10.2	130.0	Female	Labrador	Nearshore	1996	Aug	71.43	22.58	3.03	2.97	5.67
	10.3	135.0	Unk	Labrador	Nearshore	1996	Aug	57.81	29.56	9.02	3.61	9.34
	10.9	139.0	Female	Labrador	Nearshore	1996	Aug	71.01	20.73	5.42	2.83	6.21
	10.9	153.0	Unk	Labrador	Nearshore	1996	Aug	69.44	21.16	5.97	3.43	6.5
	11.1	139.0	Unk	Labrador	Nearshore	1996	Aug	71.23	20.13	5.57	3.07	6.14
	11.1	141.0	Male	Labrador	Nearshore	1996	Aug	73.91	18.98	4.51	2.59	5.51
	12.0	140.0	Male	Labrador	Nearshore	1996	Aug	88.24	8.23	2.52	1.01	2.6
	12.1	145.0	Unk	Labrador	Nearshore	1996	Aug	73.08	20.31	3.12	3.49	5.25
	13.2	153.0	Unk	Labrador	Nearshore	1996	Aug	69.32	21.84	6.1	2.74	6.69
	13.5	158.0	Unk	Labrador	Nearshore	1996	Aug	70.21	20.12	6.53	3.14	6.5
	14.0	155.0	Female	Labrador	Nearshore	1996	Aug	79.79	14.57	3.69	1.96	4.32

Appendix B: Proximate Composition of Prey (cont.)

Greenland	19.8	138.0	Unk	E Nfld	Offshore	1995	Oct	78.77	13.52	4.74	2.97	4.51
Halibut	24.0	143.5	Unk	E Nfld	Offshore	1992	Jan	78.03	13.27	6.13	1.76	4.52
	32.2	162.0	Unk	E Nfld	Offshore	1995	Oct	81.47	12.51	3.62	2.41	3.88
	33.9	159.0	Male	E Nfld	Offshore	1995	Oct	76.89	12.15	8.61	2.34	5.7
	35.1	159.0	Unk	E Nfld	Offshore	1995	Oct	82.55	11.71	3.67	2.08	3.74
	35.6	163.0	Unk	E Nfld	Offshore	1995	Oct	78.86	12.38	6.59	2.17	4.98
	36.2	165.0	Unk	E Nfld	Offshore	1995	Oct	78.93	12.27	6.4	2.39	4.89
	36.4	169.0	Male	E Nfld	Offshore	1995	Oct	79.36	11.61	6.07	2.96	4.63
	40.4	173.0	Male	E Nfld	Offshore	1995	Oct	75.15	12.92	9.34	2.59	6.13
	42.1	170.0	Male	E Nfld	Offshore	1995	Oct	79.05	12.27	6.11	2.58	4.77
	42.2	161.0	Male	E Nfld	Offshore	1995	Oct	79.2	11.15	6.77	2.88	4.8
	42.9	183.0	Male	E Nfld	Offshore	1995	Oct	78.42	11.54	7.33	2.72	5.09
	44.2	169.0	Male	E Nfld	Offshore	1995	Oct	79.21	13.33	5.87	1.58	4.9
	48.1	184.0	Male	E Nfld	Offshore	1995	Oct	78.62	12.21	7.44	1.73	5.27
	48.8	168.0	Male	E Nfld	Offshore	1995	Oct	76.91	11.74	8.82	2.54	5.7
	49.3	173.0	Male	E Nfld	Offshore	1995	Oct	79.49	13.95	4.5	2.05	4.5
	49.7	177.0	Male	E Nfld	Offshore	1995	Oct	75.81	11.83	9.65	2.72	6.03
	64.5	193.0	Male	E Nfld	Offshore	1995	Oct	81.16	11.55	5.17	2.12	4.28
	64.7	207.5	Unk	E Nfld	Offshore	1992	Jan	78.21	10.55	6.91	1.37	4.36
	68.7	205.0	Male	E Nfld	Offshore	1995	Oct	80.15	11.84	5.92	2.09	4.62
	71.4	201.0	Male	E Nfld	Offshore	1995	Oct	76.49	14.38	6.53	2.6	5.36
	73.5	209.0	Female	E Nfld	Offshore	1995	Oct	78.5	9.1	10.33	2.08	5.74
	77.3	201.0	Female	E Nfld	Offshore	1995	Oct	78.85	12.13	6.79	2.23	5.01
	78.0	200.0	Male	E Nfld	Offshore	1995	Oct	78.93	12.02	7.07	1.98	5.09
	80.3	222.0	Female	E Nfld	Offshore	1995	Oct	73.89	12.59	11.23	2.29	6.79
	88.4	209.0	Male	E Nfld	Offshore	1995	Oct	73.74	13.29	10.91	2.06	6.8
	88.8	211.0	Male	E Nfld	Offshore	1995	Oct	75.61	14.97	8.43	0.99	6.2
	88.8	216.0	Male	E Nfld	Offshore	1995	Oct	81.1	11.79	5.15	1.96	4.31
	89.3	215.0	Male	E Nfld	Offshore	1995	Oct	80.33	11.49	5.72	2.45	4.47
	99.9	205.0	Male	E Nfld	Offshore	1995	Oct	78.51	10.84	8.13	2.52	5.26
	113.0	239.0	Male	E Nfld	Offshore	1995	Oct	78.59	12.74	6.79	1.88	5.13
	119.5	236.0	Male	E Nfld	Offshore	1995	Oct	75.89	13.08	8.91	2.12	6.0
	122.7	235.0	Female	E Nfld	Offshore	1995	Oct	79.05	11.68	7.33	1.94	5.12
	129.0	249.0	Male	E Nfld	Offshore	1995	Oct	81.89	10.98	5.32	1.81	4.22
	132.5	274.5	Unk	E Nfld	Offshore	1992	Jan	76.3	12.78	9.27	1.65	5.62
	137.8	250.0	Female	E Nfld	Offshore	1995	Oct	76.73	11.88	9.54	1.86	6.0
	140.0	235.0	Male	E Nfld	Offshore	1995	Oct	78.63	11.0	8.39	1.98	5.39
	154.1	269.5	Unk	E Nfld	Offshore	1992	Jan	75.73	12.78	9.78	1.63	5.82
	181.1	275.0	Male	E Nfld	Offshore	1995	Oct	78.61	12.37	7.08	1.95	5.16
	186.2	268.0	Male	E Nfld	Offshore	1995	Oct	74.18	11.44	11.88	2.5	6.8
	188.4	279.0	Female	E Nfld	Offshore	1995	Oct	77.04	12.93	8.0	2.02	5.63
	284.0	305.0	Female	E Nfld	Offshore	1995	Oct	71.62	12.65	13.54	2.19	7.67
	310.8	333.5	Unk	E Nfld	Offshore	1992	Jan	74.9	12.7	10.6	1.8	6.1
	316.3	338.5	Unk	E Nfld	Offshore	1992	Jan	72.6	11.8	13.7	1.9	7.13
	386.1	368.5	Unk	E Nfld	Offshore	1992	Jan	69.4	12.9	16.1	1.7	8.21
	427.6	368.5	Unk	E Nfld	Offshore	1992	Jan	68.87	17.97	11.63	1.53	7.38
	484.8	388.5	Unk	E Nfld	Offshore	1992	Jan	69.4	12.9	16.0	1.7	8.18
	562.1	398.5	Unk	E Nfld	Offshore	1992	Jan	69.9	11.9	16.6	1.6	8.24
Pandalus	7.8	20.0	Male	NE Nfld	Offshore	1995	Oct	72.73	18.34	3.12	5.81	4.85

Appendix B: Proximate Composition of Prey (cont.)

Pandalus	10.3	21.5	Male	NE Nfld	Offshore	1995	Oct	77.27	14.67	3.14	4.92	4.13
borealis	10.5	22.0	Male	NE Nfld	Offshore	1995	Oct	73.91	17.21	4.18	4.7	5.03
Northern	10.8	23.5	Male	NE Nfld	Offshore	1995	Oct	70.27	19.5	5.71	4.52	6.07
Shrimp	11.2	22.0	Female	NE Nfld	Offshore	1995	Oct	75.0	17.06	2.79	5.15	4.47
	11.2	23.0	Male	NE Nfld	Offshore	1995	Oct	71.62	18.79	4.66	4.93	5.53
	11.4	23.0	Male	NE Nfld	Offshore	1995	Oct	71.79	19.01	4.54	4.66	5.53
	11.4	23.0	Male	NE Nfld	Offshore	1995	Oct	75.0	16.05	4.07	4.88	4.76
	11.5	23.0	Female	NE Nfld	Offshore	1995	Oct	74.07	17.88	3.74	4.31	5.0
	11.7	22.0	Female	NE Nfld	Offshore	1995	Oct	76.19	16.15	3.63	4.03	4.61
	11.7	23.0	Female	NE Nfld	Offshore	1995	Oct	75.29	15.85	4.31	4.55	4.81
	11.7	24.0	Female	NE Nfld	Offshore	1995	Oct	74.68	17.17	3.1	5.05	4.61
	11.9	23.0	Female	NE Nfld	Offshore	1995	Oct	77.91	14.75	2.79	4.55	4.01
	12.0	22.5	Female	NE Nfld	Offshore	1995	Oct	73.86	17.58	4.14	4.42	5.09
	12.0	23.0	Female	NE Nfld	Offshore	1995	Oct	77.01	15.4	3.21	4.38	4.3
	12.1	23.0	Female	NE Nfld	Offshore	1995	Oct	75.0	16.81	4.2	3.99	4.96
	12.3	23.0	Female	NE Nfld	Offshore	1995	Oct	76.4	16.16	3.35	4.09	4.5
	12.4	23.5	Female	NE Nfld	Offshore	1995	Oct	73.33	17.95	3.96	4.76	5.1
	12.4	23.5	Female	NE Nfld	Offshore	1995	Oct	77.17	15.8	2.64	4.39	4.16
	12.5	23.0	Female	NE Nfld	Offshore	1995	Oct	72.53	19.1	3.95	4.42	5.32
	12.5	23.5	Female	NE Nfld	Offshore	1995	Oct	78.02	16.3	1.43	4.25	3.8
	12.5	24.0	Male	NE Nfld	Offshore	1995	Oct	71.91	19.22	4.75	4.12	5.65
	12.6	23.0	Female	NE Nfld	Offshore	1995	Oct	74.19	17.26	3.96	4.59	4.96
	12.8	23.0	Female	NE Nfld	Offshore	1995	Oct	73.68	18.27	3.44	4.61	4.96
	12.8	23.0	Female	NE Nfld	Offshore	1995	Oct	75.53	17.18	2.74	4.55	4.48
	12.9	23.5	Female	NE Nfld	Offshore	1995	Oct	75.0	16.59	4.11	4.29	4.88
	13.1	23.5	Female	NE Nfld	Offshore	1995	Oct	76.29	16.51	2.38	4.82	4.21
	13.2	24.5	Female	NE Nfld	Offshore	1995	Oct	73.0	18.12	4.24	4.64	5.24
	13.3	23.5	Female	NE Nfld	Offshore	1995	Oct	74.75	17.38	2.87	5.0	4.57
	14.8	25.0	Female	NE Nfld	Offshore	1995	Oct	76.32	16.82	2.39	4.47	4.27
Redfish		18.1	Unk	E Nfld	Offshore	1991	Oct	76.74	12.09	4.55	3.61	3.73
		20.0	Unk	E Nfld	Offshore	1991	Oct	72.2	16.58	7.87	3.82	5.73
		22.0	Unk	E Nfld	Offshore	1991	Oct	75.38	12.34	5.21	4.0	4.02
		22.6	Unk	E Nfld	Offshore	1991	Oct	75.43	14.58	4.99	3.81	4.31
		23.7	Unk	E Nfld	Offshore	1991	Oct	77.94	12.25	7.1	2.98	4.72
	28.4	114.0	Unk	S Nfld	Nearshore	1996	Jan	76.84	14.96	4.46	3.73	4.69
	31.9	117.0	Unk	S Nfld	Nearshore	1996	Jan	77.57	15.83	2.91	3.69	4.27
	33.0	127.0	Male	S Nfld	Nearshore	1996	Jan	76.7	15.22	2.92	5.16	4.15
	33.4	119.0	Male	S Nfld	Nearshore	1996	Jan	78.22	15.66	2.51	3.61	4.09
	34.2	121.0	Male	S Nfld	Nearshore	1996	Jan	75.97	19.55	4.48	3.79	5.61
	36.4	126.0	Unk	S Nfld	Nearshore	1996	Jan	74.61	15.91	5.55	3.93	5.29
	37.1	124.0	Male	S Nfld	Nearshore	1996	Jan	75.0	16.17	5.13	3.7	5.18
	41.5	132.0	Male	S Nfld	Nearshore	1996	Jan	77.2	10.68	7.81	4.31	5.1
	41.8	134.0	Female	S Nfld	Nearshore	1996	Jan	75.91	18.92	5.17	3.69	5.75
	43.1	142.0	Unk	S Nfld	Nearshore	1996	Jan	73.42	21.07	5.51	4.59	6.31
	58.5	152.0	Male	S Nfld	Nearshore	1996	Jan	74.47	13.1	8.03	4.4	5.67
	60.7	146.0	Male	S Nfld	Nearshore	1996	Jan	74.0	15.73	6.46	3.8	5.6
	61.5	154.0	Male	S Nfld	Nearshore	1996	Jan	76.68	18.85	4.46	2.94	5.47
	66.8	160.0	Male	S Nfld	Nearshore	1996	Jan	72.86	16.06	7.48	3.6	6.05
	71.7	163.0	Male	S Nfld	Nearshore	1996	Jan	75.45	15.22	5.38	3.95	5.09

Appendix B: Proximate Composition of Prey (cont.)

Redfish	81.1	164.0	Female	S Nfld	Nearshore	1996	Jan	71.04	17.41	9.98	1.57	7.27
	91.8	186.0	Male	S Nfld	Nearshore	1996	Jan	78.88	15.37	1.9	3.84	3.8
	93.9	175.0	Female	S Nfld	Nearshore	1996	Jan	74.19	16.05	4.97	4.79	5.1
	115.3	197.0	Female	S Nfld	Nearshore	1996	Jan	76.57	15.0	3.67	4.75	4.4
	135.7	215.0	Male	S Nfld	Nearshore	1996	Jan	73.44	16.56	6.17	3.82	5.66
	142.3	219.0	Female	S Nfld	Nearshore	1996	Jan	73.85	15.93	5.46	4.76	5.26
	191.5	243.0	Male	S Nfld	Nearshore	1996	Jan	75.03	16.03	5.13	3.81	5.15
	250.7	264.0	Male	S Nfld	Nearshore	1996	Jan	72.49	15.39	7.62	4.5	5.97
	290.4	264.0	Male	S Nfld	Nearshore	1996	Jan	73.1	16.44	6.12	4.33	5.62
	291.8	290.0	Male	S Nfld	Nearshore	1996	Jan	76.9	16.12	2.91	4.07	4.33
	297.1	261.0	Male	S Nfld	Nearshore	1996	Jan	73.57	17.16	5.72	3.54	5.61
	312.4	290.0	Male	S Nfld	Nearshore	1996	Jan	72.58	16.07	7.4	3.95	6.03
	320.3	278.0	Male	S Nfld	Nearshore	1996	Jan	74.65	15.81	4.97	4.57	5.05
	321.8	284.0	Male	S Nfld	Nearshore	1996	Jan	71.09	16.44	8.58	3.89	6.55
	327.7	288.0	Female	S Nfld	Nearshore	1996	Jan	73.7	17.04	6.31	2.94	5.81
	337.4	268.0	Male	S Nfld	Nearshore	1996	Jan	73.17	17.88	5.25	3.7	5.57
	338.5	289.0	Male	S Nfld	Nearshore	1996	Jan	74.96	16.31	4.86	3.88	5.11
	340.7	273.0	Male	S Nfld	Nearshore	1996	Jan	70.96	15.33	11.39	2.32	7.39
	348.9	280.0	Male	S Nfld	Nearshore	1996	Jan	72.35	15.27	8.72	3.66	6.37
	351.6	288.0	Male	S Nfld	Nearshore	1996	Jan	75.04	15.75	5.26	3.96	5.15
	356.5	295.0	Male	S Nfld	Nearshore	1996	Jan	74.64	16.26	5.13	3.97	5.2
	358.8	290.0	Male	S Nfld	Nearshore	1996	Jan	75.34	15.9	4.94	3.82	5.06
	362.1	290.0	Male	S Nfld	Nearshore	1996	Jan	71.38	17.2	7.71	3.71	6.37
	366.6	294.0	Male	S Nfld	Nearshore	1996	Jan	73.55	15.31	5.98	5.16	5.33
	367.3	278.0	Male	S Nfld	Nearshore	1996	Jan	75.98	16.1	4.13	3.79	4.79
	373.7	295.0	Male	S Nfld	Nearshore	1996	Jan	73.4	15.36	7.21	4.02	5.81
	373.9	289.0	Male	S Nfld	Nearshore	1996	Jan	73.62	18.21	6.03	2.14	5.93
	377.0	294.0	Female	S Nfld	Nearshore	1996	Jan	71.12	15.66	9.71	3.51	6.82
	381.1	303.0	Male	S Nfld	Nearshore	1996	Jan	72.53	16.58	7.41	3.48	6.13
	382.2	293.0	Female	S Nfld	Nearshore	1996	Jan	75.41	17.86	4.63	2.1	5.33
	428.7	299.0	Female	S Nfld	Nearshore	1996	Jan	70.89	17.0	8.4	3.71	6.59
Sand	10.0	159.0	Male	NE Nfld	Offshore	1995	Dec	77.61	15.6	3.87	2.92	4.59
Lance	11.0	162.0	Female	NE Nfld	Offshore	1995	Dec	82.89	15.09	0.95	1.07	3.38
	11.2	168.0	Male	NE Nfld	Offshore	1995	Dec	83.33	13.82	0.77	2.08	3.06
	11.5	172.0	Male	NE Nfld	Offshore	1995	Dec	82.05	14.84	0.82	2.29	3.28
	11.7	166.0	Male	NE Nfld	Offshore	1995	Dec	79.52	16.16	1.3	3.02	3.73
	12.0	158.0	Male	E Nfld	Offshore	1996	June	74.39	17.28	5.78	2.55	5.65
	12.2	165.0	Female	E Nfld	Offshore	1996	June	78.57	17.14	1.83	2.46	4.12
	12.2	171.0	Male	NE Nfld	Offshore	1995	Dec	79.76	15.99	2.07	2.18	3.98
	12.6	172.0	Male	E Nfld	Offshore	1996	June	74.16	19.98	3.1	2.76	5.17
	12.9	170.0	Male	NE Nfld	Offshore	1995	Dec	79.35	14.72	3.09	2.83	4.12
	12.9	174.0	Female	E Nfld	Offshore	1996	June	73.63	16.36	7.39	2.62	6.08
	12.9	179.0	Male	E Nfld	Offshore	1996	June	84.44	11.8	1.62	2.14	2.97
	12.9	181.0	Male	NE Nfld	Offshore	1995	Dec	79.17	16.13	1.58	3.12	3.83
	13.0	169.0	Male	NE Nfld	Offshore	1995	Dec	77.32	16.45	3.25	2.98	4.52
	13.4	167.0	Male	E Nfld	Offshore	1996	June	76.29	17.7	3.5	2.51	4.87
	13.8	176.0	Male	E Nfld	Offshore	1996	June	75.0	18.38	4.16	2.46	5.26
	13.9	169.0	Male	E Nfld	Offshore	1996	June	76.77	16.97	3.85	2.41	4.86
	14.3	172.0	Male	E Nfld	Offshore	1996	June	78.1	17.66	1.67	2.57	4.17

Appendix B: Proximate Composition of Prey (cont.)

Sand	14.5	172.0	Male	NE Nfld	Offshore	1995	Dec	73.64	16.4	7.04	2.92	5.96
Lance	14.5	179.0	Female	E Nfld	Offshore	1996	June	75.7	17.79	3.79	2.72	5.0
	14.8	175.0	Female	E Nfld	Offshore	1996	June	77.48	17.19	2.81	2.52	4.51
	14.8	186.0	Female	NE Nfld	Offshore	1995	Dec	79.82	16.05	2.08	2.04	4.0
	15.1	126.0	Female	E Nfld	Offshore	1996	June	78.76	16.03	2.63	2.58	4.2
	15.1	174.0	Female	E Nfld	Offshore	1996	June	77.48	17.7	2.37	2.45	4.44
	15.1	183.0	Male	E Nfld	Offshore	1996	June	79.46	17.21	0.77	2.56	3.73
	15.5	177.0	Male	E Nfld	Offshore	1996	June	76.07	18.59	3.31	2.03	4.97
	15.8	180.0	Female	E Nfld	Offshore	1996	June	78.69	18.02	0.92	2.37	3.95
	16.0	175.0	Male	E Nfld	Offshore	1996	June	75.21	15.71	6.09	2.99	5.46
	16.2	211.0	Male	NE Nfld	Offshore	1995	Dec	80.8	16.07	0.65	2.48	3.46
	16.4	191.0	Female	E Nfld	Offshore	1996	June	79.37	16.76	0.8	3.07	3.66
	16.4	204.0	Female	NE Nfld	Offshore	1995	Dec	81.89	14.47	0.7	2.94	3.16
	17.1	195.0	Male	E Nfld	Offshore	1996	June	76.52	17.26	3.9	2.32	4.93
	17.3	184.0	Female	E Nfld	Offshore	1996	June	74.81	18.58	4.07	2.54	5.26
	17.3	190.0	Male	E Nfld	Offshore	1996	June	78.36	17.27	1.56	2.81	4.05
	17.6	190.0	Female	E Nfld	Offshore	1996	June	75.36	18.07	4.02	2.55	5.14
	18.7	190.0	Male	E Nfld	Offshore	1996	June	77.55	19.54	1.64	1.27	4.53
	19.0	183.0	Male	NE Nfld	Offshore	1995	Dec	73.86	16.48	7.09	2.57	5.99
	19.3	200.0	Male	E Nfld	Offshore	1996	June	76.47	16.95	4.47	2.11	5.09
	20.9	195.0	Female	NE Nfld	Offshore	1995	Dec	75.6	16.03	5.84	2.53	5.43
	23.7	220.0	Female	E Nfld	Offshore	1996	June	78.46	16.48	1.92	3.14	4.02
	27.0	225.0	Female	NE Nfld	Offshore	1995	Dec	77.06	16.0	3.88	3.06	4.67
Squid	7.7	47.0	Unk	Labrador	Offshore	1996	Sept	76.47	12.23	9.67	1.63	6.12
(*Gonatus*)	8.2	62.0	Unk	Labrador	Offshore	1996	Sept	76.74	14.63	6.6	2.03	5.43
	8.5	76.0	Unk	Labrador	Offshore	1996	Sept	78.26	15.09	4.22	2.43	4.62
	11.4	66.0	Unk	Labrador	Offshore	1996	Sept	73.33	14.06	10.59	2.02	6.84
	11.5	65.0	Unk	Labrador	Offshore	1996	Sept	81.08	11.66	5.92	1.34	4.58
	12.0	70.0	Unk	Labrador	Offshore	1996	Sept	75.64	14.38	7.55	2.43	5.75
	12.6	65.0	Unk	Labrador	Offshore	1996	Sept	77.65	14.63	5.85	1.87	5.15
	12.6	75.0	Unk	Labrador	Offshore	1996	Sept	78.82	13.17	6.28	1.73	5.02
	12.8	67.0	Unk	Labrador	Offshore	1996	Sept	73.81	13.1	11.5	1.59	6.99
	13.0	70.0	Unk	Labrador	Offshore	1996	Sept	75.58	13.13	9.38	1.91	6.19
	13.1	72.0	Unk	Labrador	Offshore	1996	Sept	69.89	14.74	13.32	2.05	8.01
	13.5	74.0	Unk	Labrador	Offshore	1996	Sept	79.12	12.25	6.78	1.85	5.03
	13.9	76.0	Unk	Labrador	Offshore	1996	Sept	75.26	11.62	10.29	2.83	6.23
	14.5	79.0	Unk	Labrador	Offshore	1996	Sept	78.22	11.43	9.36	0.99	5.84
	15.4	76.0	Unk	Labrador	Offshore	1996	Sept	71.68	14.03	12.05	2.24	7.38
	15.5	75.0	Unk	Labrador	Offshore	1996	Sept	74.34	13.0	10.92	1.74	6.75
	15.8	79.0	Unk	Labrador	Offshore	1996	Sept	77.68	13.53	7.27	1.52	5.47
	16.0	79.0	Unk	Labrador	Offshore	1996	Sept	71.31	14.07	12.66	1.96	7.62
	17.1	77.0	Unk	Labrador	Offshore	1996	Sept	72.87	13.15	12.09	1.89	7.22
	17.5	80.0	Unk	Labrador	Offshore	1996	Sept	63.53	21.33	11.28	3.86	8.55
	18.3	69.0	Unk	Labrador	Offshore	1996	Sept	73.29	11.53	13.24	1.94	7.34
	18.5	78.0	Unk	Labrador	Offshore	1996	Sept	72.34	14.38	11.1	2.18	7.09
	18.8	75.0	Unk	Labrador	Offshore	1996	Sept	76.55	13.68	7.89	1.88	5.73
	19.0	75.0	Unk	Labrador	Offshore	1996	Sept	76.09	13.98	8.38	1.55	5.98
	19.0	87.0	Unk	Labrador	Offshore	1996	Sept	74.34	11.92	12.32	1.42	7.07
	19.2	80.0	Unk	Labrador	Offshore	1996	Sept	72.73	13.05	11.91	2.31	7.14

Appendix B: Proximate Composition of Prey (cont.)

Squid	21.3	86.0	Unk	Labrador	Offshore	1996	Sept	74.71	13.22	10.41	1.66	6.6
(*Gonatus*)	21.4	91.0	Unk	Labrador	Offshore	1996	Sept	73.53	14.21	10.79	1.47	6.94
	21.6	82.0	Unk	Labrador	Offshore	1996	Sept	74.1	13.84	9.95	2.11	6.55
	21.6	90.0	Unk	Labrador	Offshore	1996	Sept	69.59	14.28	13.61	2.52	8.03
	22.2	91.0	Male	Labrador	Offshore	1996	Sept	75.57	13.92	8.98	1.53	6.2
	22.7	86.0	Unk	Labrador	Offshore	1996	Sept	73.37	12.71	12.11	1.81	7.14
	23.2	86.0	Unk	Labrador	Offshore	1996	Sept	71.05	13.54	13.5	1.91	7.84
	23.7	88.0	Unk	Labrador	Offshore	1996	Sept	72.08	13.67	12.59	1.66	7.52
	24.7	87.0	Unk	Labrador	Offshore	1996	Sept	72.86	13.68	11.77	1.69	7.21
	27.3	93.0	Unk	Labrador	Offshore	1996	Sept	76.99	12.51	8.74	1.76	5.82
	32.6	94.0	Unk	Labrador	Offshore	1996	Sept	71.33	12.62	14.58	1.47	8.06
	33.1	96.0	Unk	Labrador	Offshore	1996	Sept	71.23	13.67	13.14	1.96	7.73
	33.2	102.0	Unk	Labrador	Offshore	1996	Sept	41.13	28.38	26.28	4.21	15.66
	36.0	102.0	Male	Labrador	Offshore	1996	Sept	76.87	10.58	10.8	1.74	6.22
	45.8	163.0	Male	Labrador	Offshore	1996	Sept	70.22	11.81	15.99	1.98	8.44
	46.8	117.0	Unk	Labrador	Offshore	1996	Sept	75.92	13.89	8.1	2.09	5.86
	51.5	135.0	Unk	Labrador	Offshore	1996	Sept	71.97	11.41	15.0	1.62	7.98
	87.9	125.0	Female	Labrador	Offshore	1996	Sept	64.77	14.45	19.36	1.43	10.24
Squid	58.2	255.0	Male	E Nfld	Nearshore	1993	Sept	78.28	16.33	4.12	1.28	4.83
(*Illex*)	66.2	264.0	Male	E Nfld	Nearshore	1993	Sept	76.91	17.82	3.73	1.54	4.98
	70.4	287.0	Female	E Nfld	Nearshore	1993	Sept	78.27	16.66	3.79	1.27	4.77
	83.4	265.0	Female	E Nfld	Nearshore	1993	Sept	76.62	16.82	5.18	1.38	5.33
	97.2	311.0	Male	E Nfld	Nearshore	1993	Sept	76.48	16.84	5.17	1.5	5.34
	99.8	312.0	Female	E Nfld	Nearshore	1993	Sept	76.08	17.26	5.22	1.44	5.44
	102.5	305.0	Male	E Nfld	Nearshore	1993	Sept	75.72	17.5	5.33	1.46	5.52
	120.2	323.0	Female	E Nfld	Nearshore	1993	Sept	74.86	17.68	6.05	1.4	5.84
	123.1	266.0	Male	E Nfld	Nearshore	1993	Sept	74.16	18.13	6.39	1.32	6.05
	124.9	350.0	Female	E Nfld	Nearshore	1993	Sept	73.6	17.74	7.03	1.64	6.22
	128.4	342.0	Male	E Nfld	Nearshore	1993	Sept	75.79	17.13	5.75	1.34	5.61
	133.4	324.0	Male	E Nfld	Nearshore	1993	Sept	74.2	16.61	7.87	1.32	6.31
	135.8	356.0	Female	E Nfld	Nearshore	1993	Sept	75.02	17.35	6.17	1.45	5.82
	136.8	343.0	Female	E Nfld	Nearshore	1993	Sept	75.64	17.11	5.78	1.48	5.62
	145.3	334.0	Male	E Nfld	Nearshore	1993	Sept	73.79	16.71	8.37	1.13	6.52
	146.0	354.0	Male	E Nfld	Nearshore	1993	Sept	72.49	17.81	8.21	1.49	6.68
	146.3	374.0	Male	E Nfld	Nearshore	1993	Sept	73.7	15.78	9.17	1.35	6.64
	147.0	366.0	Female	E Nfld	Nearshore	1993	Sept	75.41	17.53	5.66	1.4	5.66
	147.9	340.0	Female	E Nfld	Nearshore	1993	Sept	76.41	16.91	5.25	1.42	5.38
	150.2	375.0	Female	E Nfld	Nearshore	1993	Sept	73.71	17.64	7.08	1.57	6.22
	151.6	359.0	Female	E Nfld	Nearshore	1993	Sept	75.18	17.13	6.32	1.37	5.83
	151.9	376.0	Female	E Nfld	Nearshore	1993	Sept	75.46	16.29	6.94	1.31	5.9
	152.6	358.0	Male	E Nfld	Nearshore	1993	Sept	73.61	17.06	7.9	1.43	6.42
	153.5	357.0	Female	E Nfld	Nearshore	1993	Sept	75.85	15.72	7.06	1.37	5.83
	155.0	383.0	Male	E Nfld	Nearshore	1993	Sept	74.25	16.26	8.23	1.26	6.38
	155.7	357.0	Female	E Nfld	Nearshore	1993	Sept	73.53	17.25	7.82	1.39	6.42
	159.6	356.0	Female	E Nfld	Nearshore	1993	Sept	75.34	15.8	7.96	0.89	6.19
	166.7	370.0	Male	E Nfld	Nearshore	1993	Sept	73.38	16.36	8.75	1.51	6.6
	169.2	359.0	Female	E Nfld	Nearshore	1993	Sept	74.95	17.69	5.95	1.42	5.8
	171.3	389.0	Male	E Nfld	Nearshore	1993	Sept	74.51	16.27	7.94	1.28	6.27
	181.3	382.0	Male	E Nfld	Nearshore	1993	Sept	73.04	16.39	9.35	1.22	6.83